16-day BRDF/Albedo from L2G-lite vs L2G-heavy

Sadashiva Devadiga

Updated on 07/19/2010

Algorithm Updates and Expected Differences

- **Code Changes**
  - L2G-lite (PGE13)
    - Stores one observation per orbit
    - Ensures same state QA for an observation as in L2G-heavy
  - BRDF/Albedo (PGE23)
    - L2G-lite version of BRDF is updated to use all available L2G observations, L2G-heavy version of BRDF limits to 4 observations/day, but from different orbits.
    - In L2G-heavy version of BRDF observation from an orbit is a weighted average of 2 or more observations when more than 2 observations are available. In L2G-light an observation is a sample from an orbit.
- **Expected difference in BRDF product**
  - Strong differences are expected at high latitude. L2G-lite version of BRDF/albedo will have a better spatial coherence.
  - Do not expect identical result even in tiles close to equator, there could be small difference in reflectance input to inversion algorithm – average of observations (L2G_heavy) vs one sample observation (L2G-lite).
  - Smooth, sharp and narrow 2D scatter plots of parameters from the two difference versions (mostly with in 1% error margin – depends on sensitivity of inversion algorithm to difference in input)

Science Test

- **Science Test**
  - 16-day period global test (starting day 2003193)
  - Baseline (AS 230)
    - C5 Operational BRDF/Albedo using C5 operational version of L2G-heavy
    - C5 Operational MOD09A1 using C5 operational version of L2G-lite
  - Test (AS 243)
    - C5 (non-operational) BRDF/Albedo version using the C5 new version of L2G-lite
    - C5 Operational MOD09A1 using the C5 new version of L2G-lite
- **Data used in this analysis**
  - MOD09A1
    - h09v05 (Northwest America)
    - h20v11 (South Africa)
  - MCD43A4 (NBAR) from day 2003193 and tiles
    - h20v11 (South Africa 20 – 30 deg latitude)
    - h09v05 (Northwest America, 30 – 40 deg latitude)
    - h16v01 (Greenland, 70 – 80 deg latitude)

Analysis of MOD09A1

- **Algorithm Change Verification**
  - No change in MOD09A1 (PGE21) PGE. The test and baseline use operational C5 version of the PGE which uses L2G-lite as input.
  - Baseline used the operational L2G-lite and the test used the new version of the L2G-lite.
  - In the new version of the L2G-lite pointers to the 1km observations might have changed for some of the 500m reflectance observations. This is most likely to happen and visible at the edge of cloud and aerosol patches.
  - The change in these atmospheric states causes the MOD09A1 algorithm to pick observations from a different day.

Analysis of MOD09A1: 2003193, h09v05 (1/4)

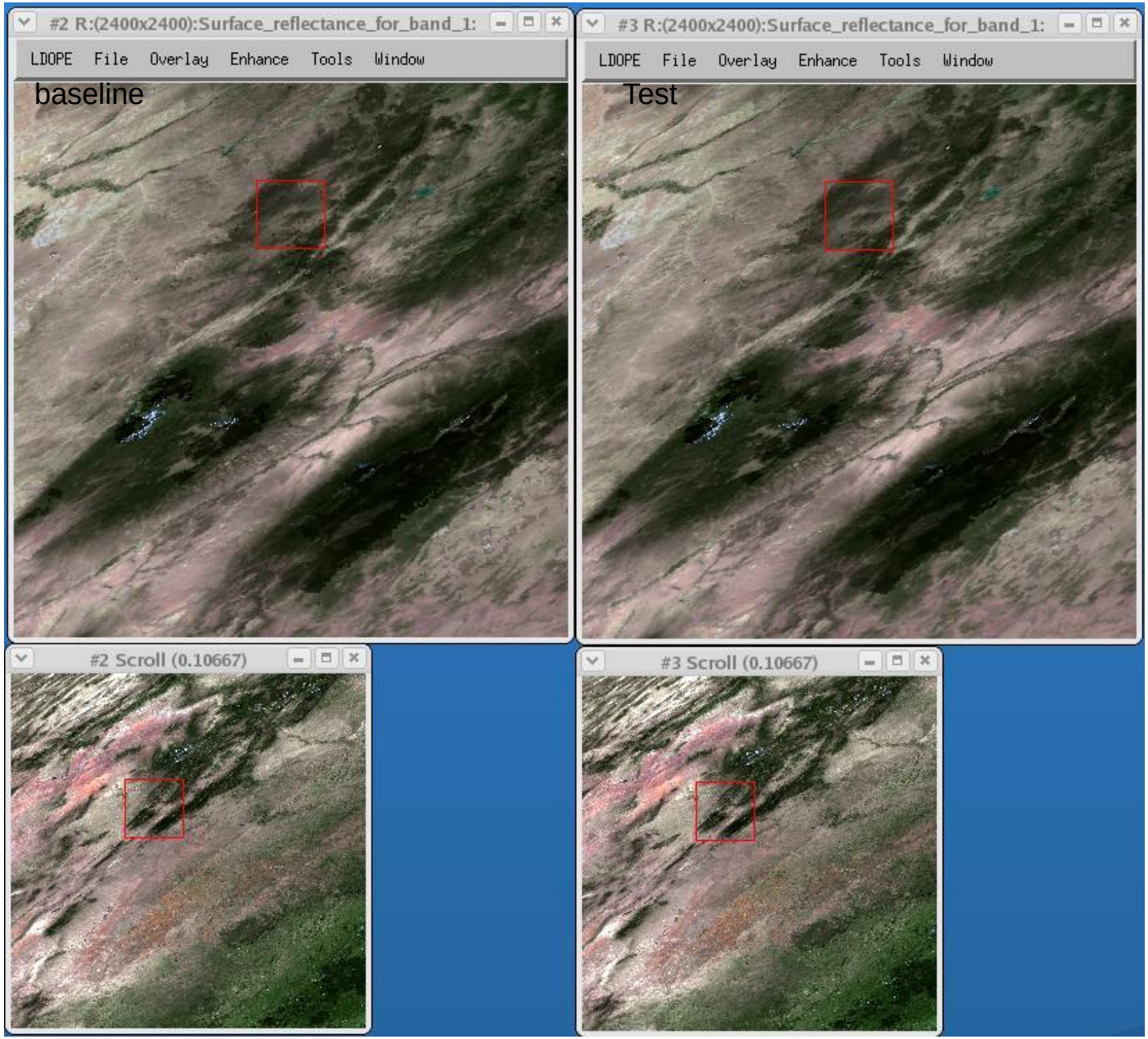


Figure shows RGB composite images of surface reflectance from bands 1, 4, and 3.

There isn't any visible differences between the baseline and the test data.

Analysis of MOD09A1: 2003193, h09v05 (2/4)

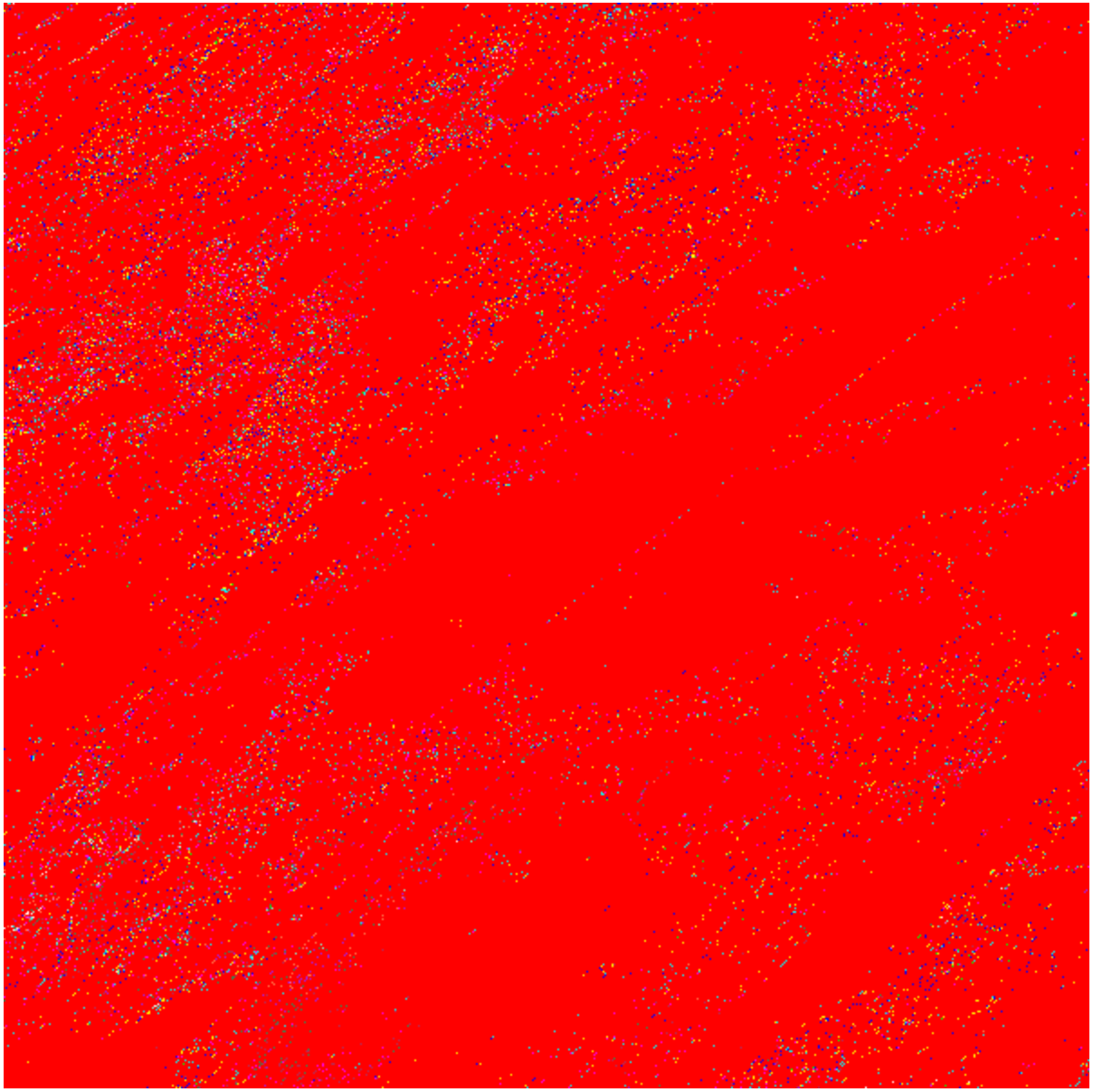
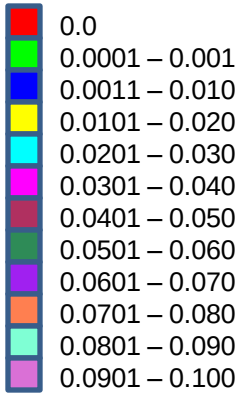


Figure shows the absolute difference in band1 surface reflectance between the baseline and test version of data. The two data versions are mostly identical except for pixels at edges of the cloud and aerosol. The difference in reflectance at these pixels could be significant since they now come from a different data day with different viewing geometry.



Analysis of MOD09A1: 2003193, h09v05 (3/4)

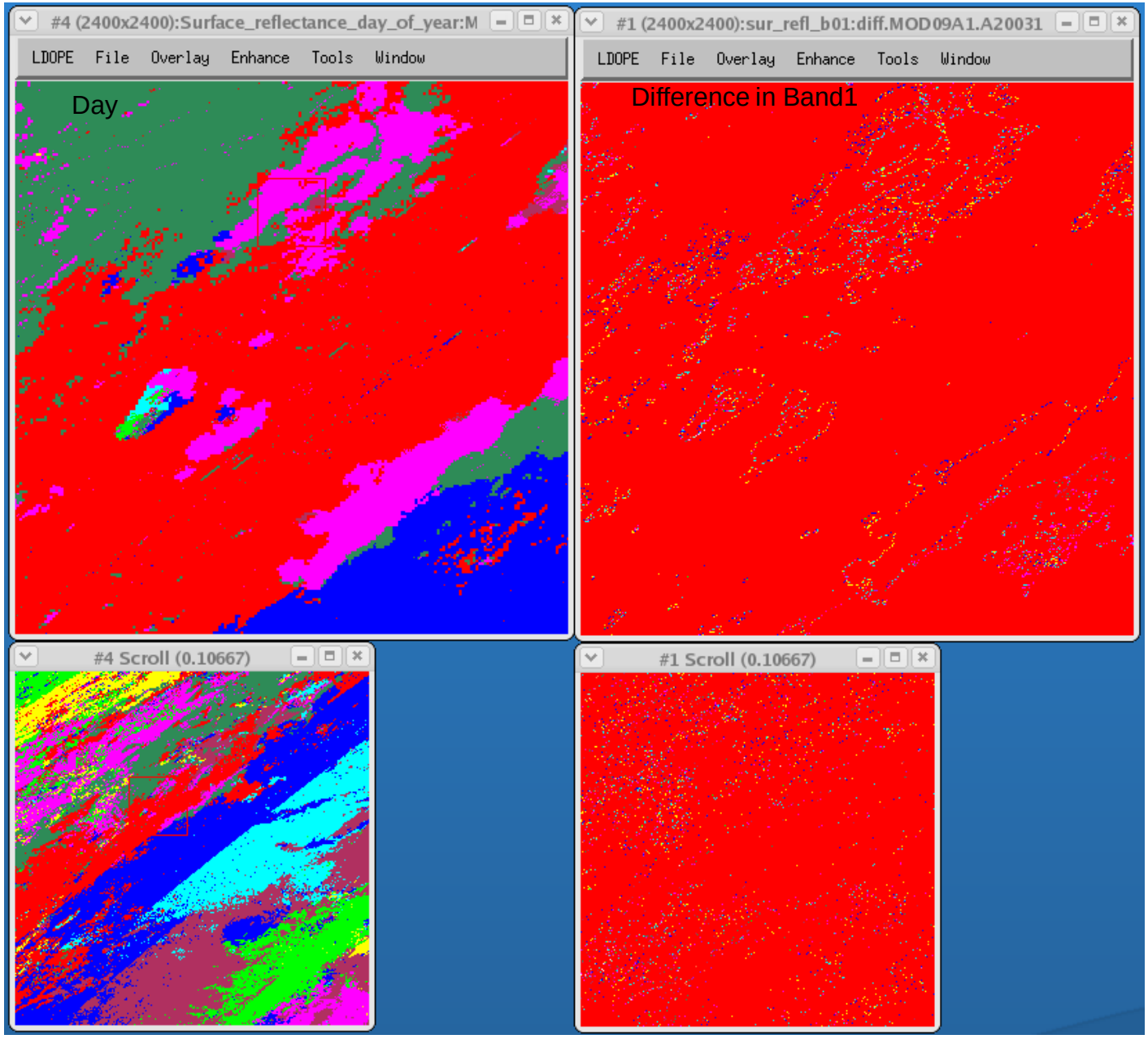


Figure shows image of the composite day number in the baseline and image of difference in band1 surface reflectance. The new version seems to pick a different day at edges of cloud or aerosol, because of possibly different 1km observation in the new L2G-lite.

Absolute difference

- 0.0
- 0.0001 – 0.001
- 0.0011 – 0.010
- 0.0101 – 0.020
- 0.0201 – 0.030
- 0.0301 – 0.040
- 0.0401 – 0.050
- 0.0501 – 0.060
- 0.0601 – 0.070
- 0.0701 – 0.080
- 0.0801 – 0.090
- 0.0901 – 0.100

Composite Day

- 193
- 194
- 195
- 196
- 197
- 198
- 199
- 201

Analysis of MOD09A1: 2003193, h09v05 (4/4)

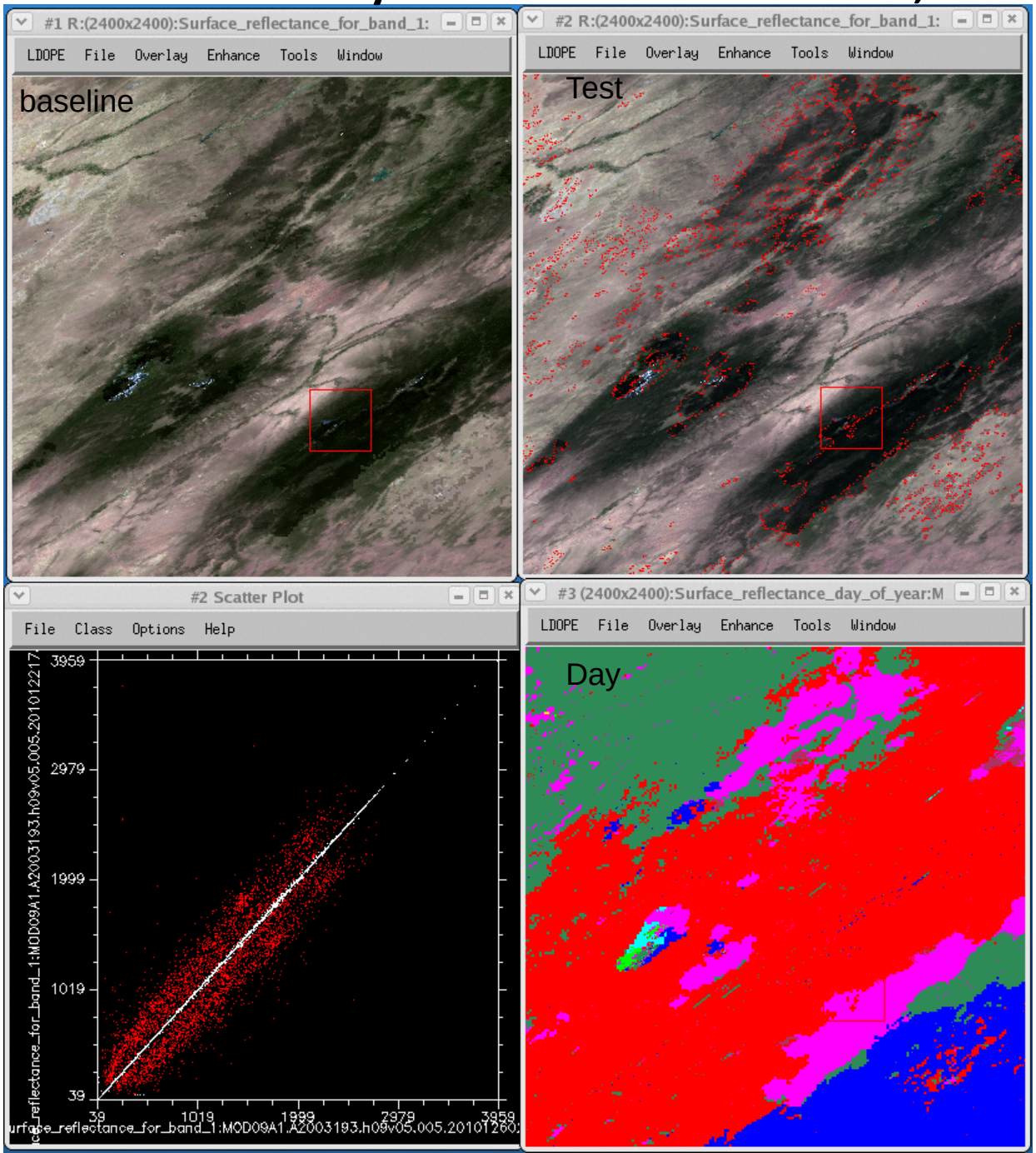
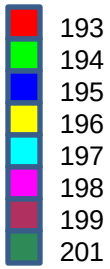


Figure shows RGB composite images from bands 1, 4, and 3, the scatter plot of band1 surface reflectance and the composite data day from the baseline.

The pixels labeled red in the RGB image from the test version of data corresponds to red points in the scatter plot. These pixels are mostly at edges where the composite day changes because of the different 1km observation in the L2G-lite.

Composite Day



Analysis of MOD09A1: 2003193, h20v11 (1/4)

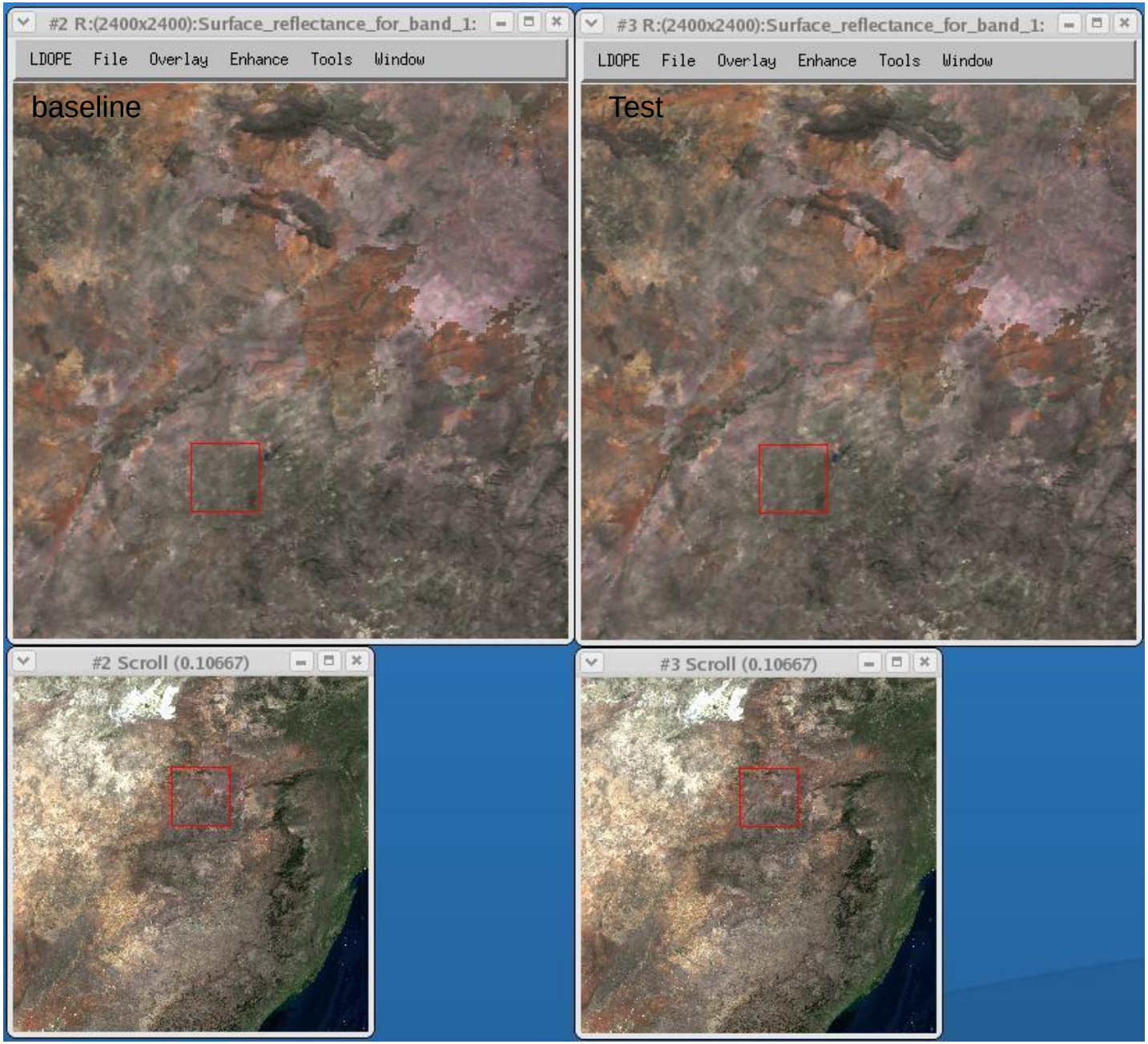


Figure shows RGB composite images of surface reflectance from bands 1, 4, and 3.

There isn't any visible differences between the baseline and the test data.

Analysis of MOD09A1: 2003193, h20v11 (2/4)

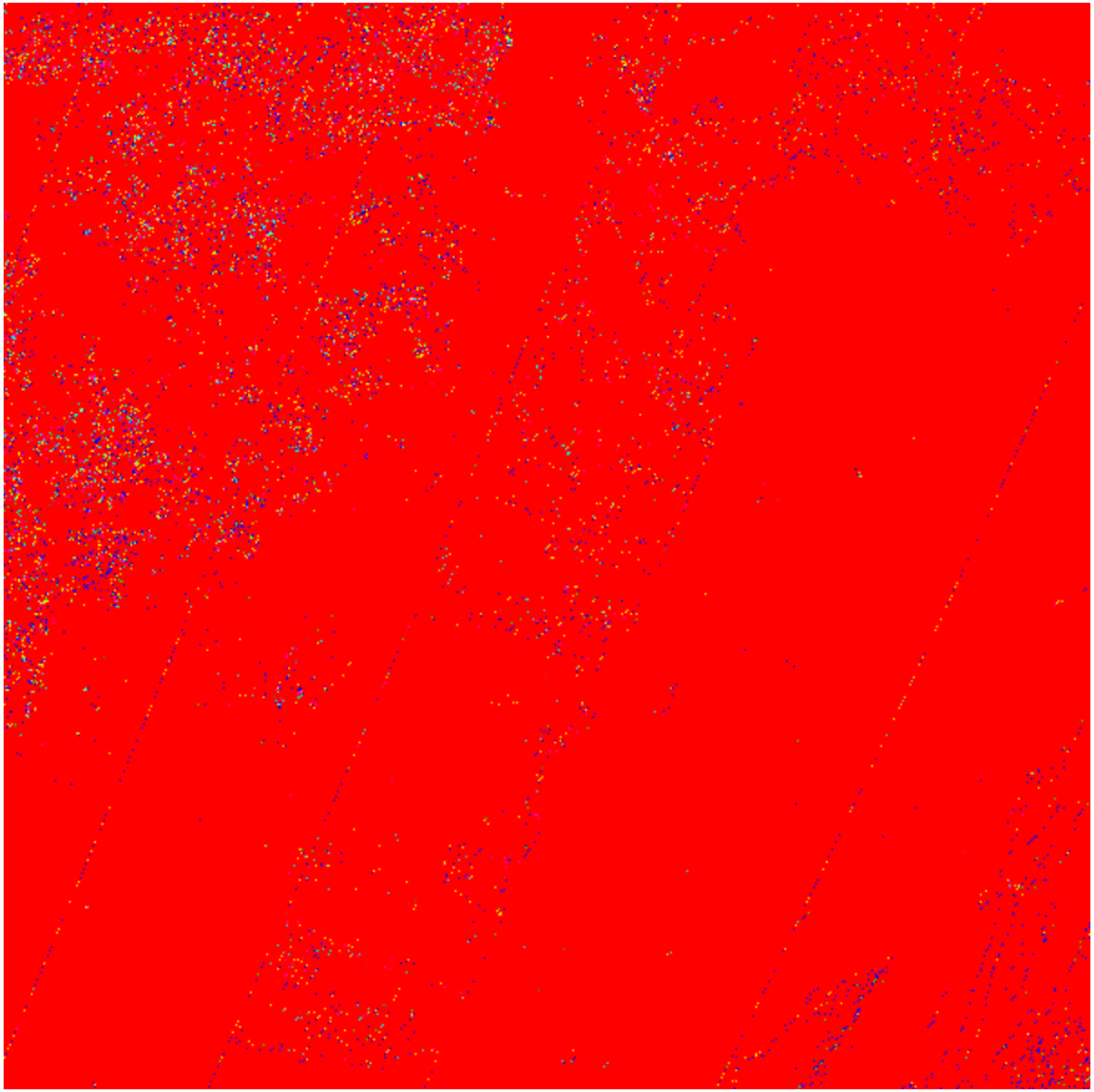
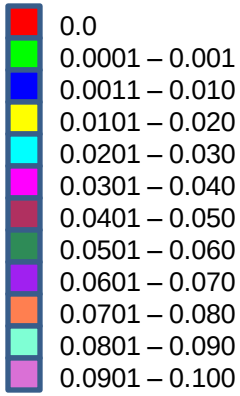


Figure shows the absolute difference in band1 surface reflectance between the baseline and test version of data. The two data versions are mostly identical except for pixels at edges of the cloud and aerosol. The difference in reflectance at these pixels could be significant since they now come from a different data day with different viewing geometry.



Analysis of MOD09A1: 2003193, h20v11(3/4)

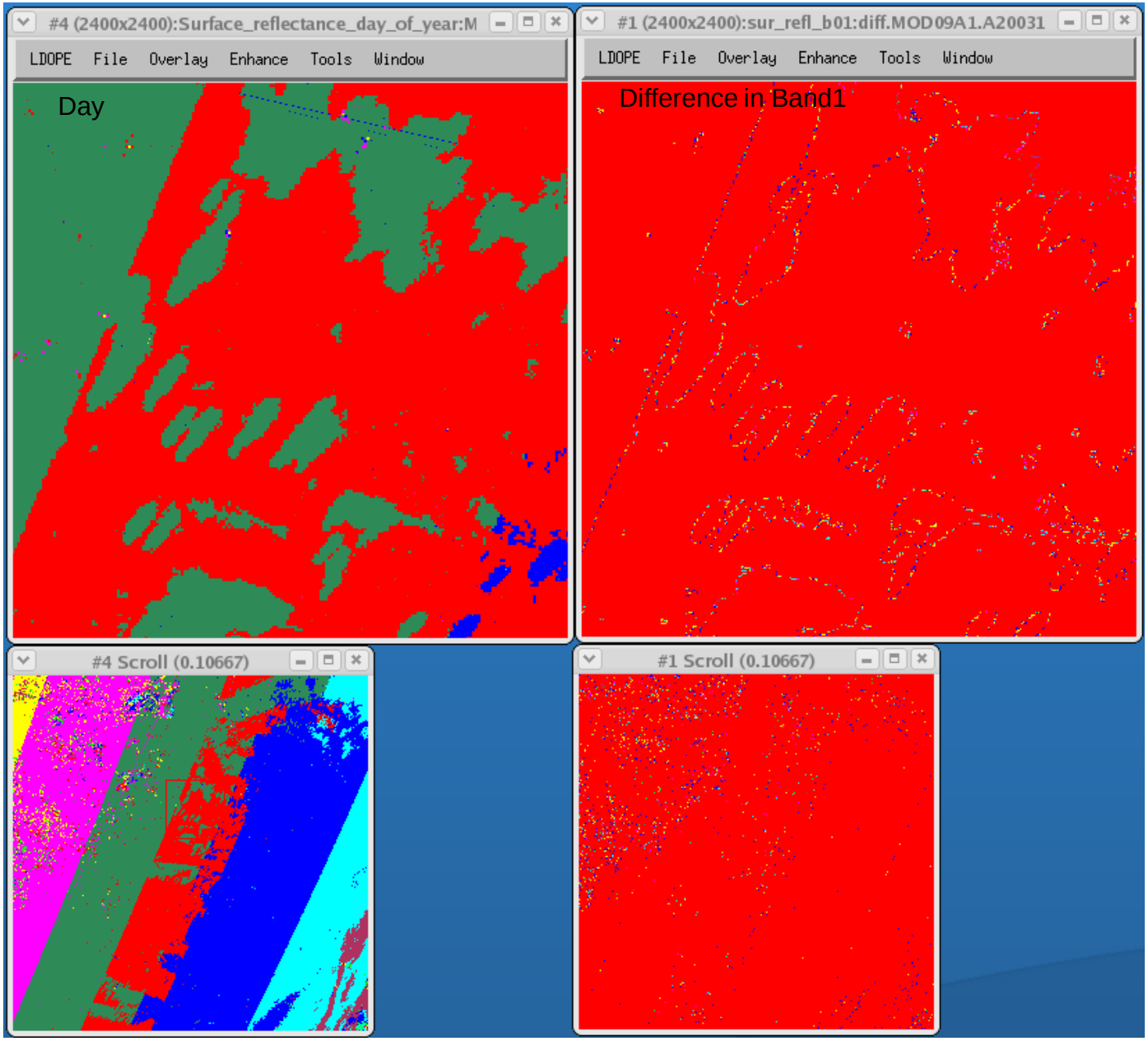


Figure shows image of the composite day number in the baseline and of difference in surface reflectance band1. The new version seems to pick a different day at edges of cloud or aerosol, because of the possibly different 1km observation in the new L2G-lite.

Absolute difference

- 0.0
- 0.0001 – 0.001
- 0.0011 – 0.010
- 0.0101 – 0.020
- 0.0201 – 0.030
- 0.0301 – 0.040
- 0.0401 – 0.050
- 0.0501 – 0.060
- 0.0601 – 0.070
- 0.0701 – 0.080
- 0.0801 – 0.090
- 0.0901 – 0.100

Composite Day

- 193
- 194
- 195
- 196
- 197
- 198
- 199
- 201

Analysis of MOD09A1: 2003193, h20v11(4/4)

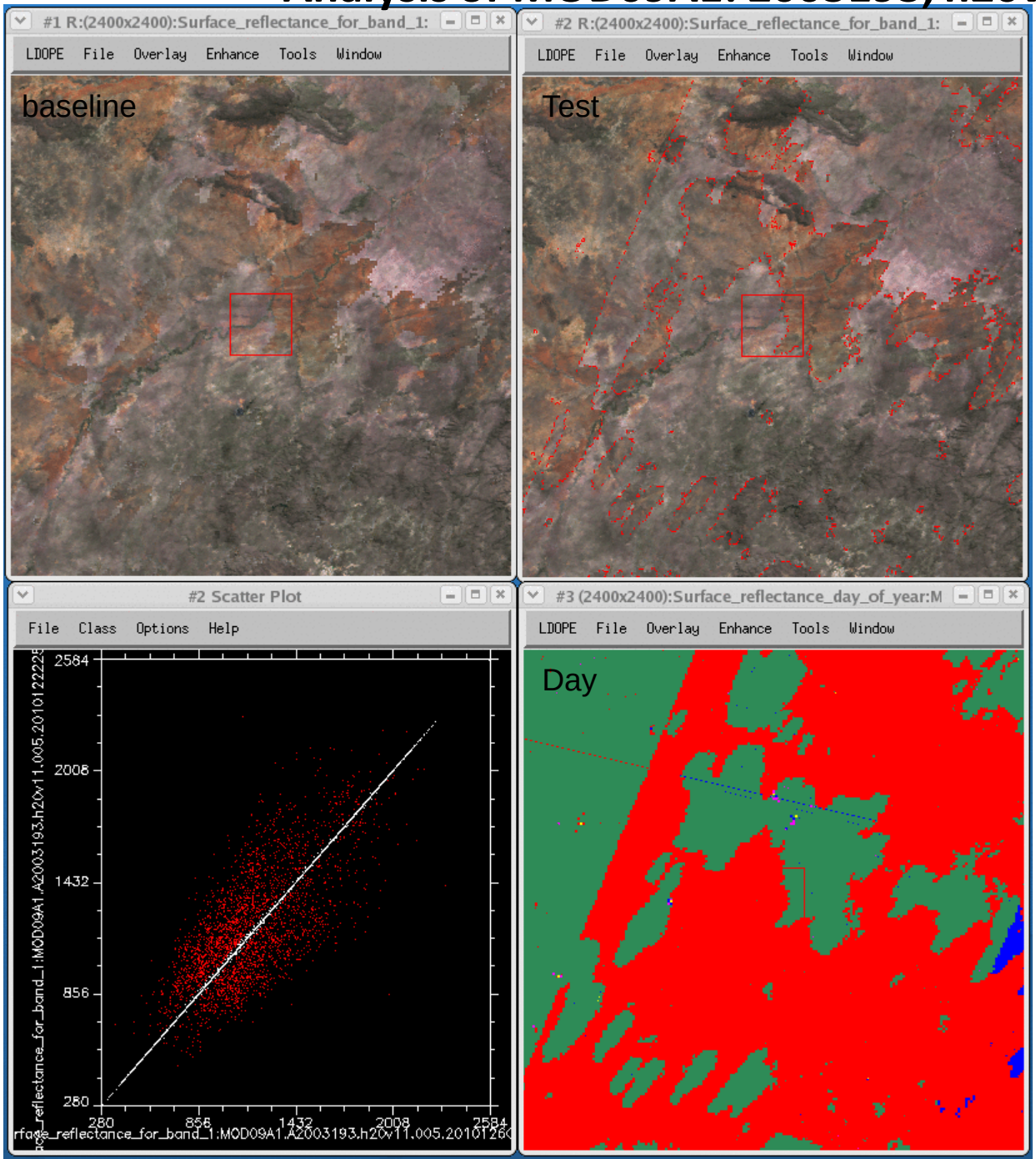


Figure shows RGB composite images from bands 1, 4, and 3, the scatter plot of band1 surface reflectance and the composite data day from the baseline.

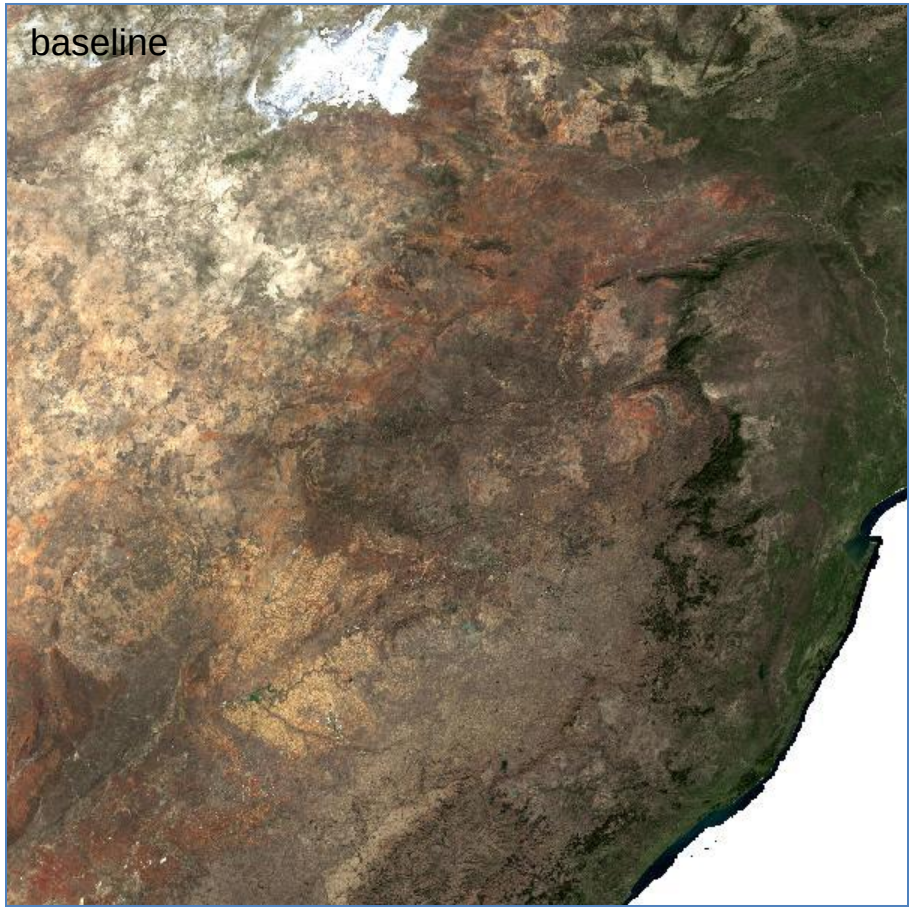
The pixels labeled red in the RGB image from the test version of data corresponds to red points in the scatter plot. These pixels are mostly at edges where the composite day changes because of the different 1km observation in the L2G-lite.

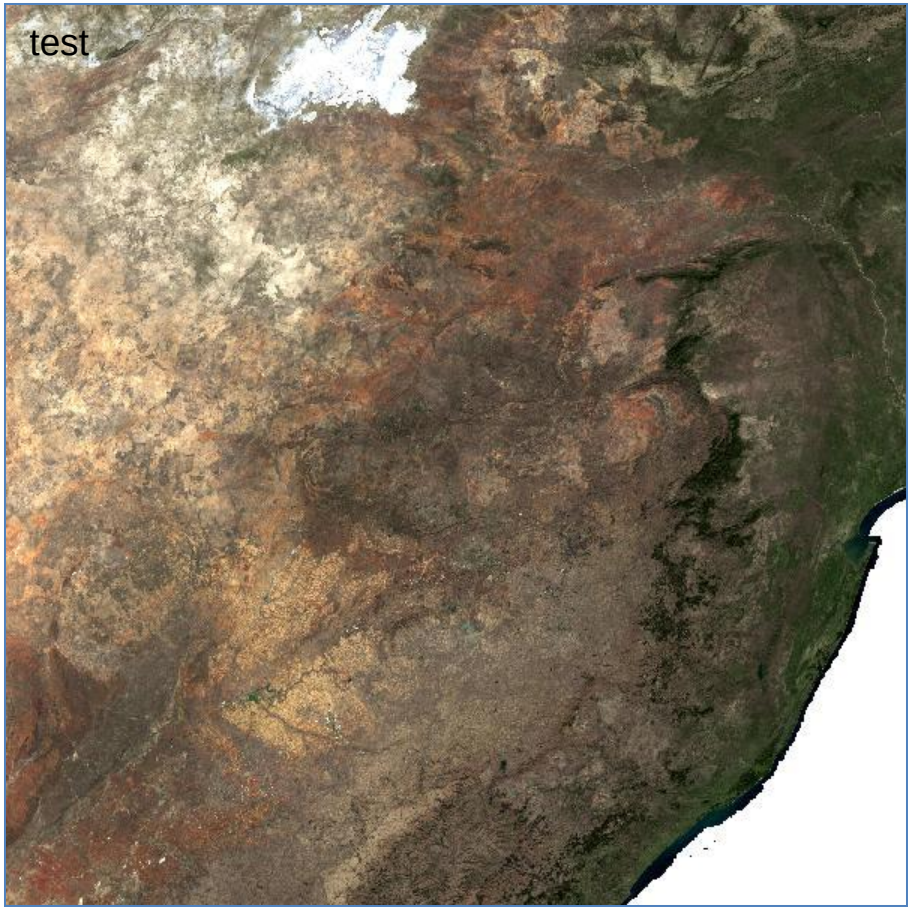
Composite Day

193
194
195
196
197
198
199
201

Analysis of BRDF/Albedo: MCD43A4, 2003193, h20v11

- RGB composite from bands 1, 3 and 4

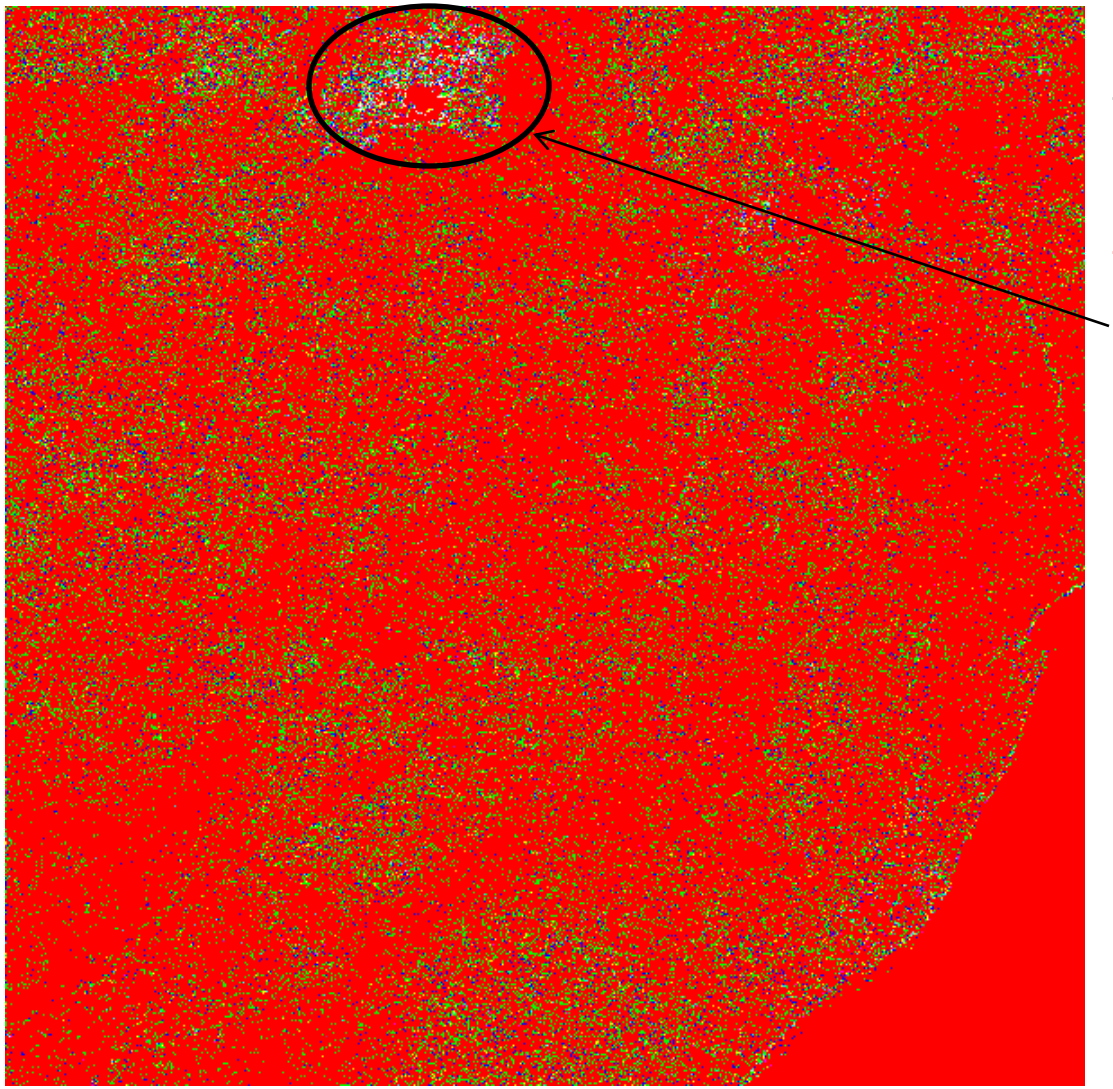




- Difference between the two version is hardly visible. following slides shows the full tile difference image followed by many spatial subsets of the two data versions, difference image and the 2D scatter plot band1 reflectance.

Analysis of BRDF/Albedo: MCD43A4, 2003193, h20v11

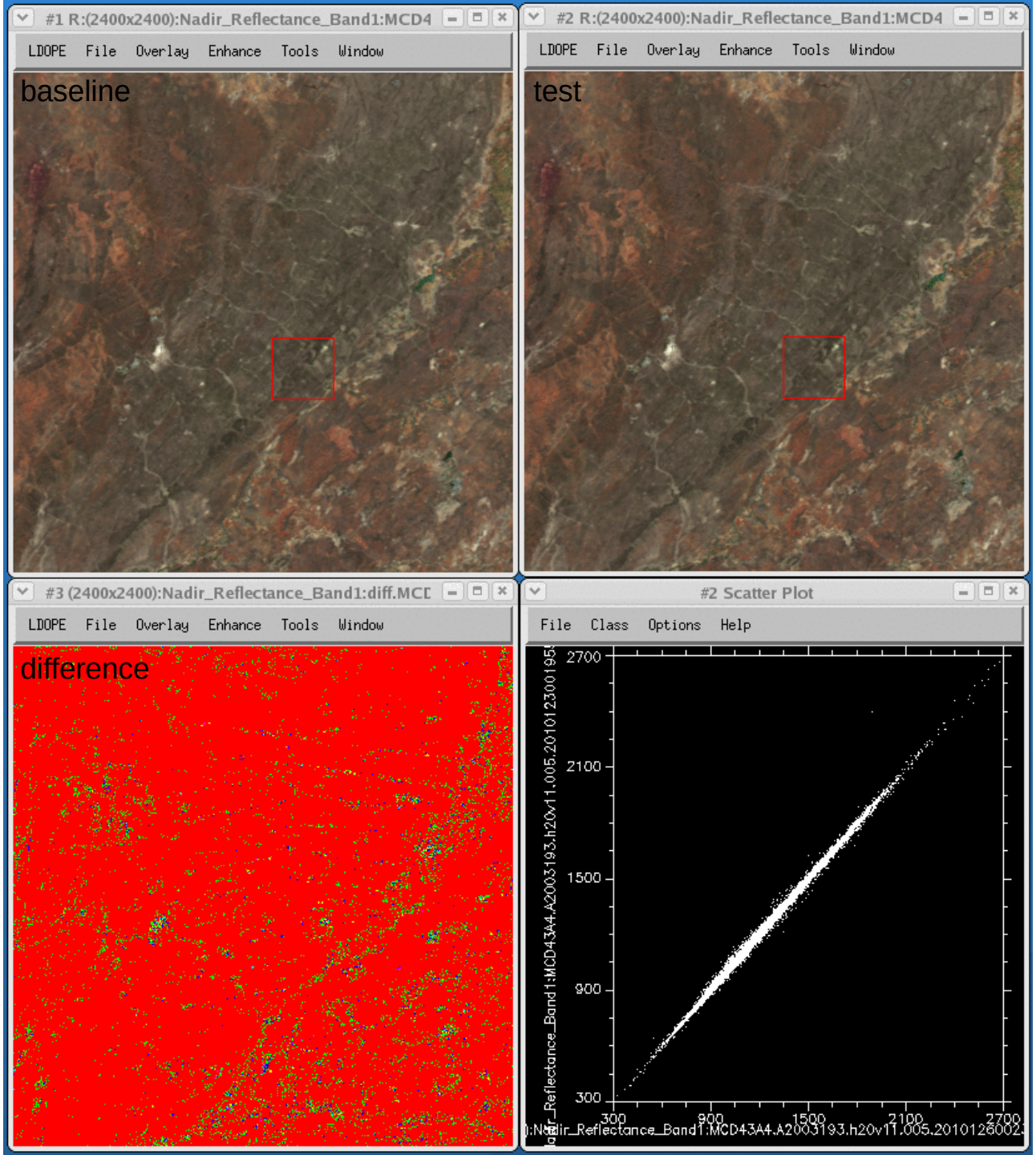
- Absolute difference in NBAR – band1 (baseline – test)

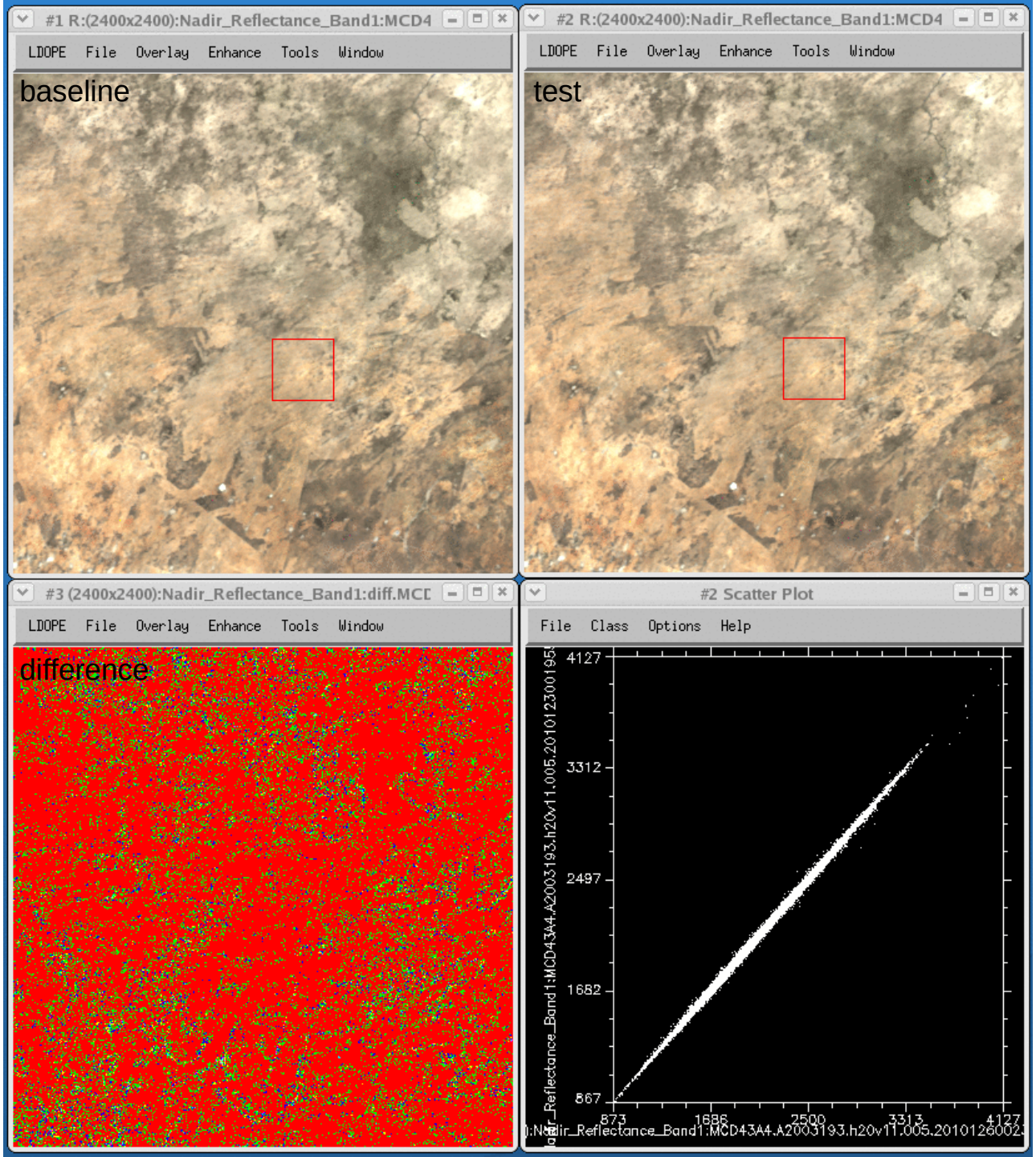


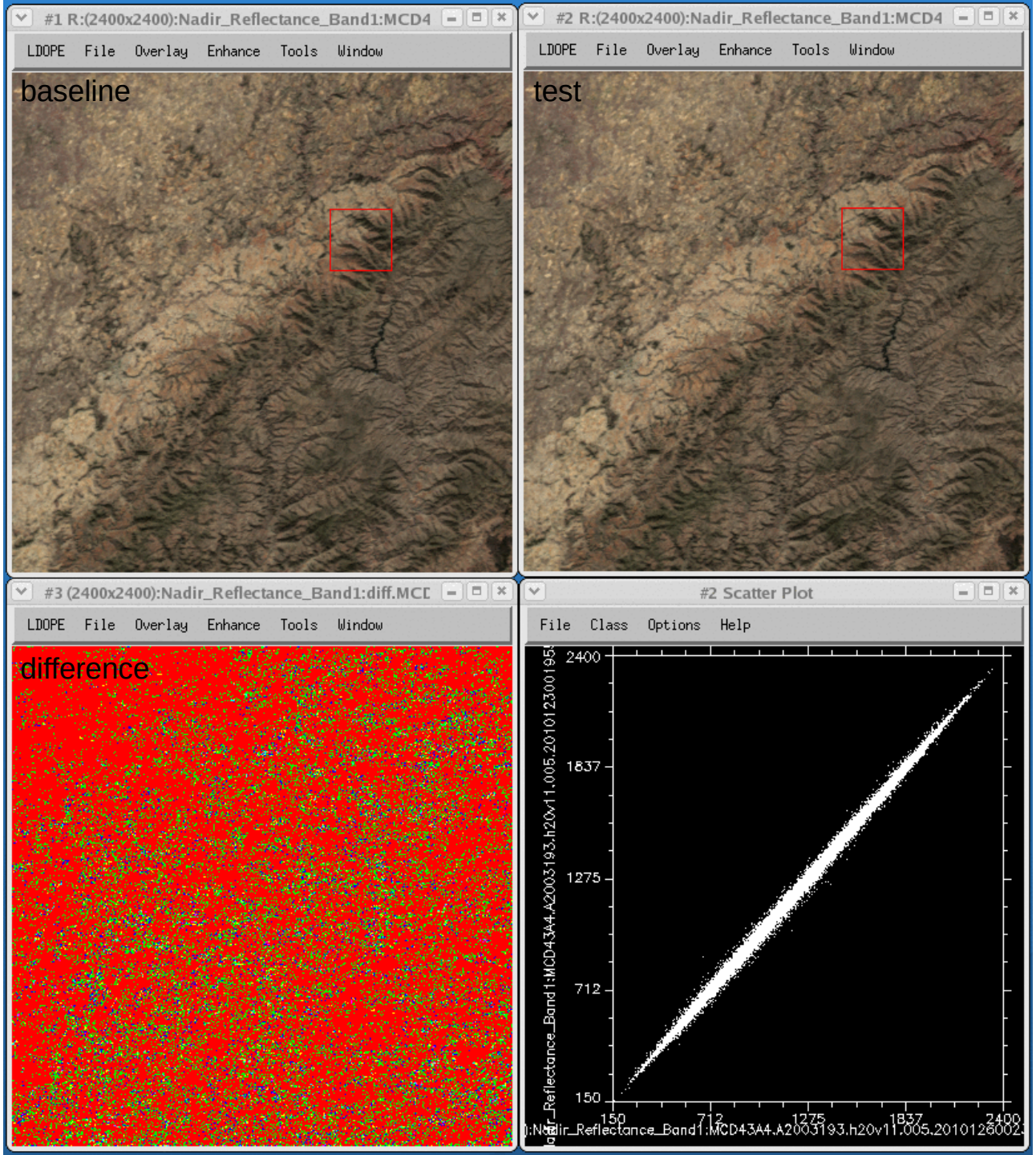
Most of the retrievals in the test version are within 0.003 of the retrieved value in the baseline version. There are few pixels for which surface reflectance could not be retrieved in the test version.

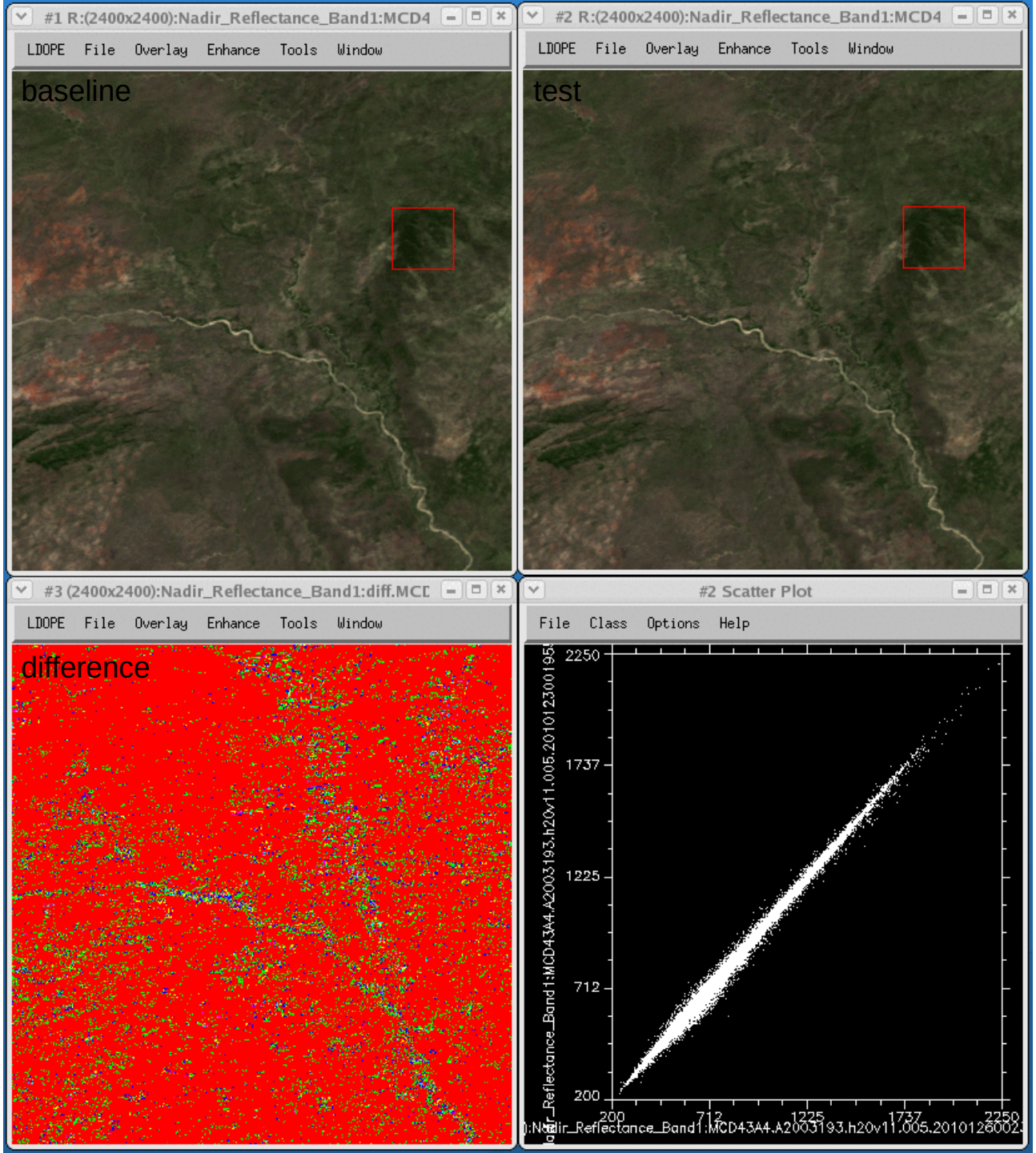
Absolute difference

- 0.0000 – 0.0010
- 0.0011 – 0.0020
- 0.0021 – 0.0030
- 0.0031 – 0.0040
- 0.0041 – 0.0050
- 0.0051 – 0.0060
- 0.0061 – 0.0070
- 0.0071 – 0.0080
- 0.0081 – 0.0090
- 0.0091 – 0.0100
- 0.0101 – 0.0200
- 0.0201 – 0.0300
- 0.0301 – 0.0400
- 0.0401 – 0.0500
- Fill value in test


#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#3 (2400x2400):Nadir_Reflectance_Band1:diff.MCD
LDOPE File Overlay Enhance Tools Window
difference
#2 Scatter Plot
File Class Options Help
2700
2100
1500
900
300
300
900
1500
2100
2700
Absolute difference
0.0000 – 0.0010
0.0011 – 0.0020
0.0021 – 0.0030
0.0031 – 0.0040
0.0041 – 0.0050
0.0051 – 0.0060
0.0061 – 0.0070
0.0071 – 0.0080
0.0081 – 0.0090
0.0091 – 0.0100
0.0101 – 0.0200
0.0201 – 0.0300
0.0301 – 0.0400
0.0401 – 0.0500
Fill value in test

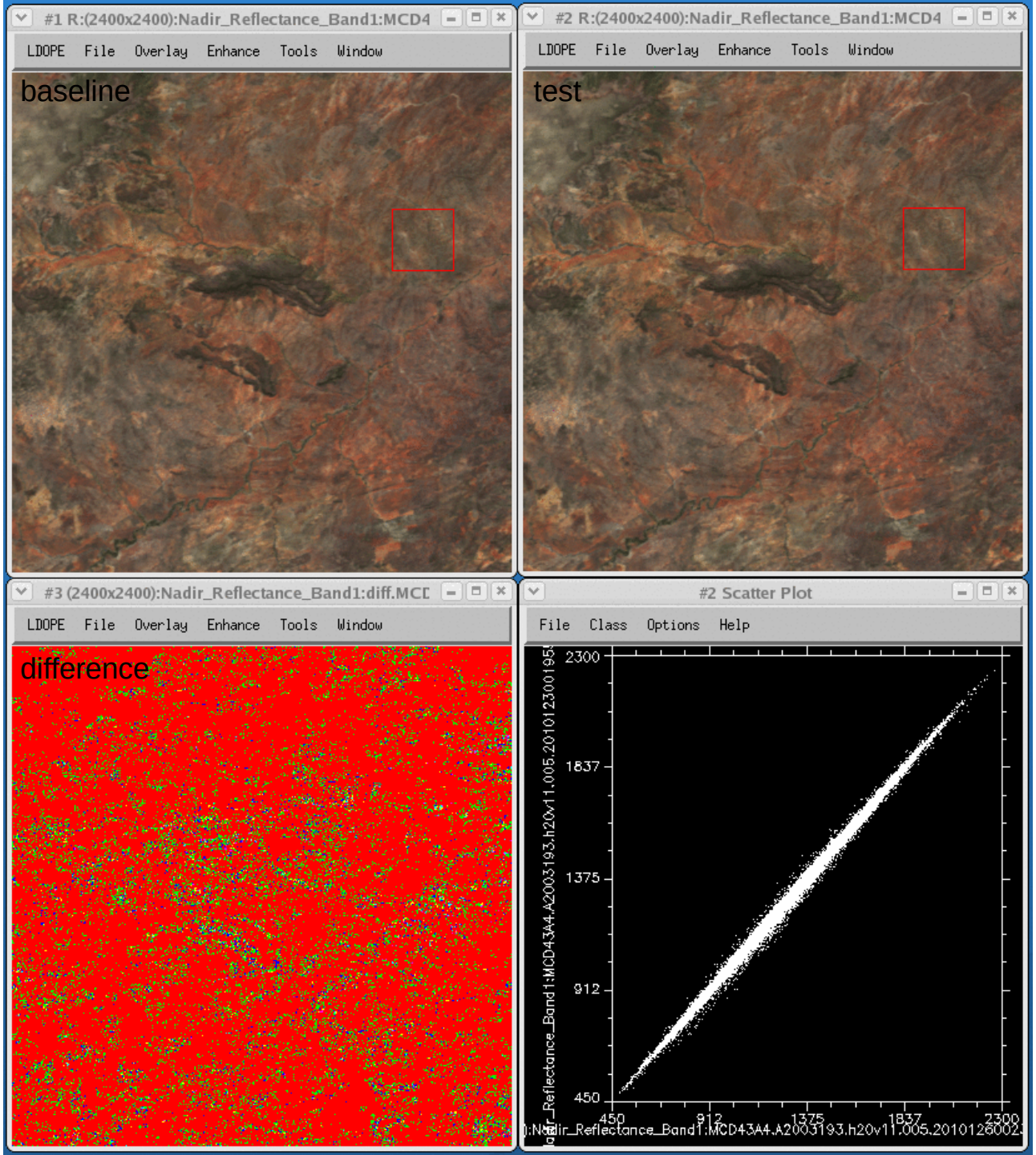

#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#3 (2400x2400):Nadir_Reflectance_Band1:diff.MCD
LDOPE File Overlay Enhance Tools Window
difference
#2 Scatter Plot
File Class Options Help
4127
3312
2497
1682
867
873
1686
2500
3313
4127
Absolute difference
0.0000 – 0.0010
0.0011 – 0.0020
0.0021 – 0.0030
0.0031 – 0.0040
0.0041 – 0.0050
0.0051 – 0.0060
0.0061 – 0.0070
0.0071 – 0.0080
0.0081 – 0.0090
0.0091 – 0.0100
0.0101 – 0.0200
0.0201 – 0.0300
0.0301 – 0.0400
0.0401 – 0.0500
Fill value in test


#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#3 (2400x2400):Nadir_Reflectance_Band1:diff.MCD
LDOPE File Overlay Enhance Tools Window
difference
#2 Scatter Plot
File Class Options Help
2400
1837
1275
712
150
150
712
1275
1837
2400
Absolute difference
0.0000 – 0.0010
0.0011 – 0.0020
0.0021 – 0.0030
0.0031 – 0.0040
0.0041 – 0.0050
0.0051 – 0.0060
0.0061 – 0.0070
0.0071 – 0.0080
0.0081 – 0.0090
0.0091 – 0.0100
0.0101 – 0.0200
0.0201 – 0.0300
0.0301 – 0.0400
0.0401 – 0.0500
Fill value in test



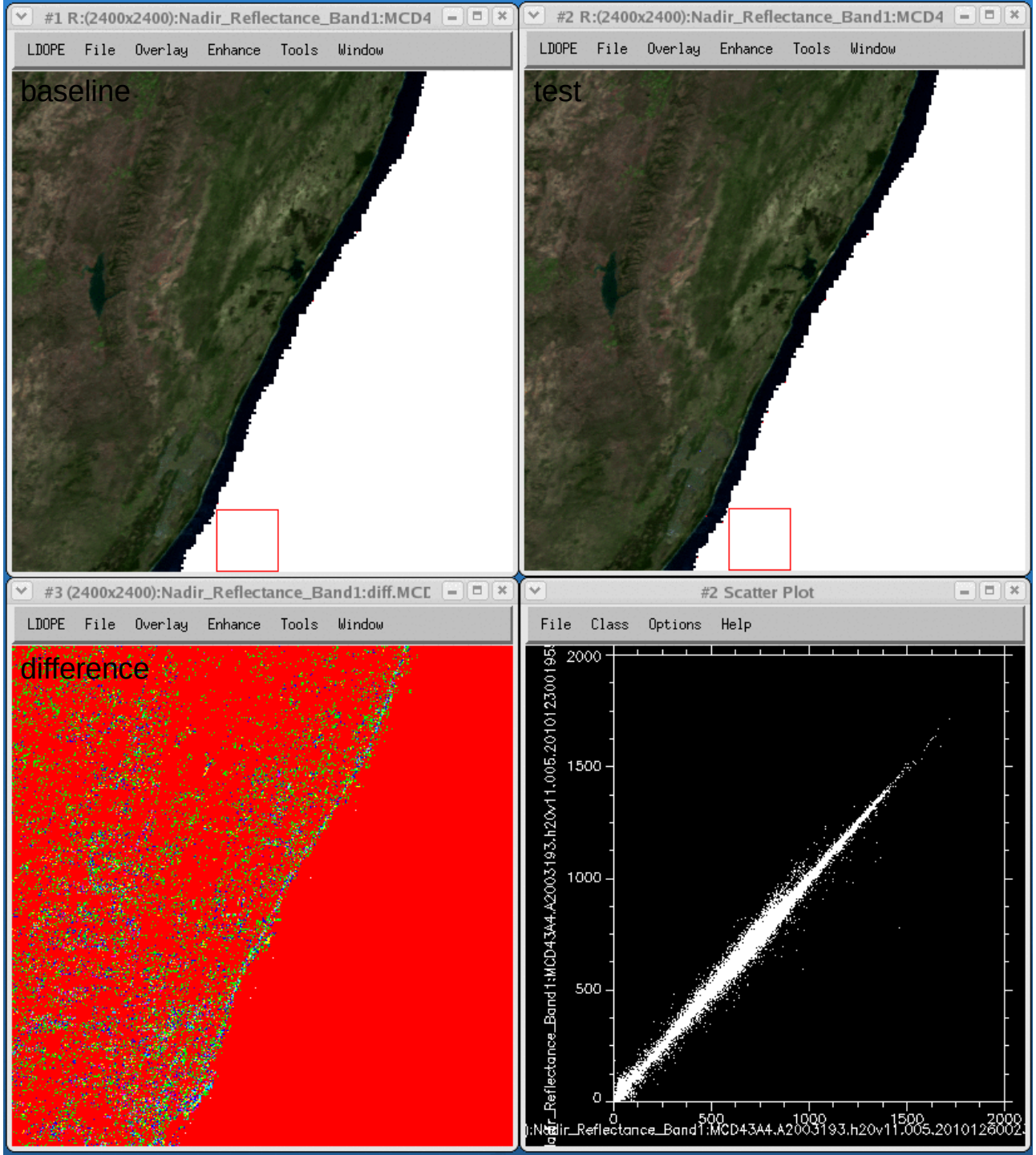
Absolute difference

- 0.0000 – 0.0010
- 0.0011 – 0.0020
- 0.0021 – 0.0030
- 0.0031 – 0.0040
- 0.0041 – 0.0050
- 0.0051 – 0.0060
- 0.0061 – 0.0070
- 0.0071 – 0.0080
- 0.0081 – 0.0090
- 0.0091 – 0.0100
- 0.0101 – 0.0200
- 0.0201 – 0.0300
- 0.0301 – 0.0400
- 0.0401 – 0.0500
- Fill value in test



Absolute difference

- 0.0000 – 0.0010
- 0.0011 – 0.0020
- 0.0021 – 0.0030
- 0.0031 – 0.0040
- 0.0041 – 0.0050
- 0.0051 – 0.0060
- 0.0061 – 0.0070
- 0.0071 – 0.0080
- 0.0081 – 0.0090
- 0.0091 – 0.0100
- 0.0101 – 0.0200
- 0.0201 – 0.0300
- 0.0301 – 0.0400
- 0.0401 – 0.0500
- Fill value in test

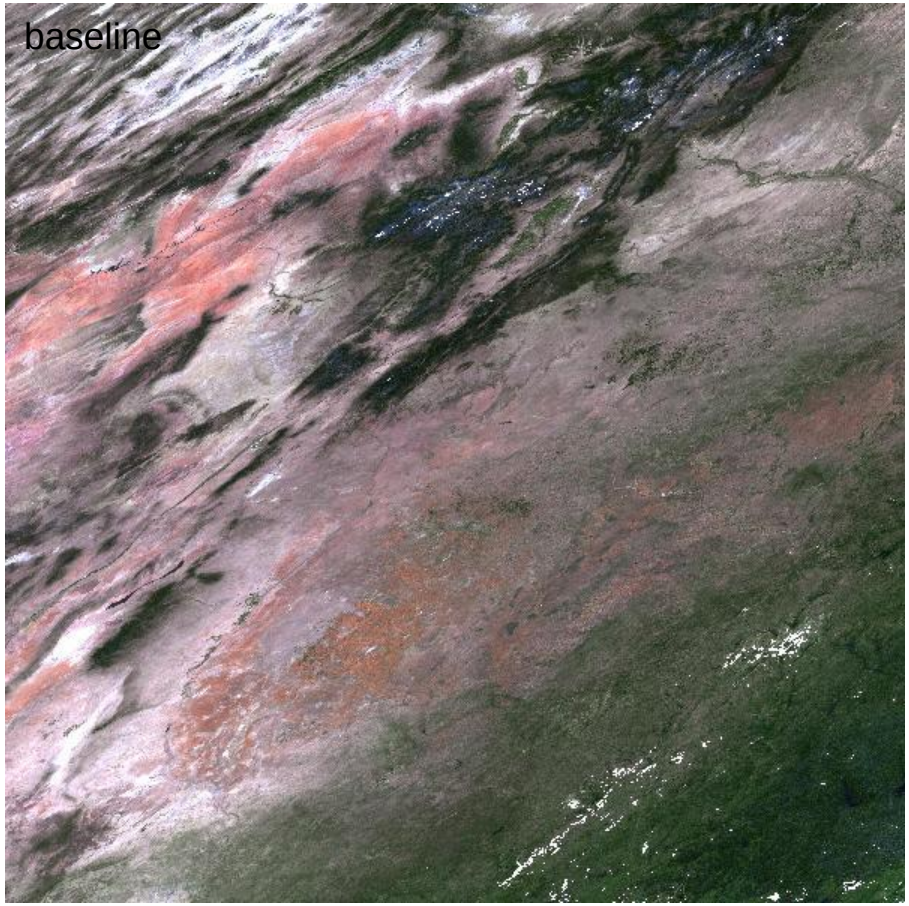


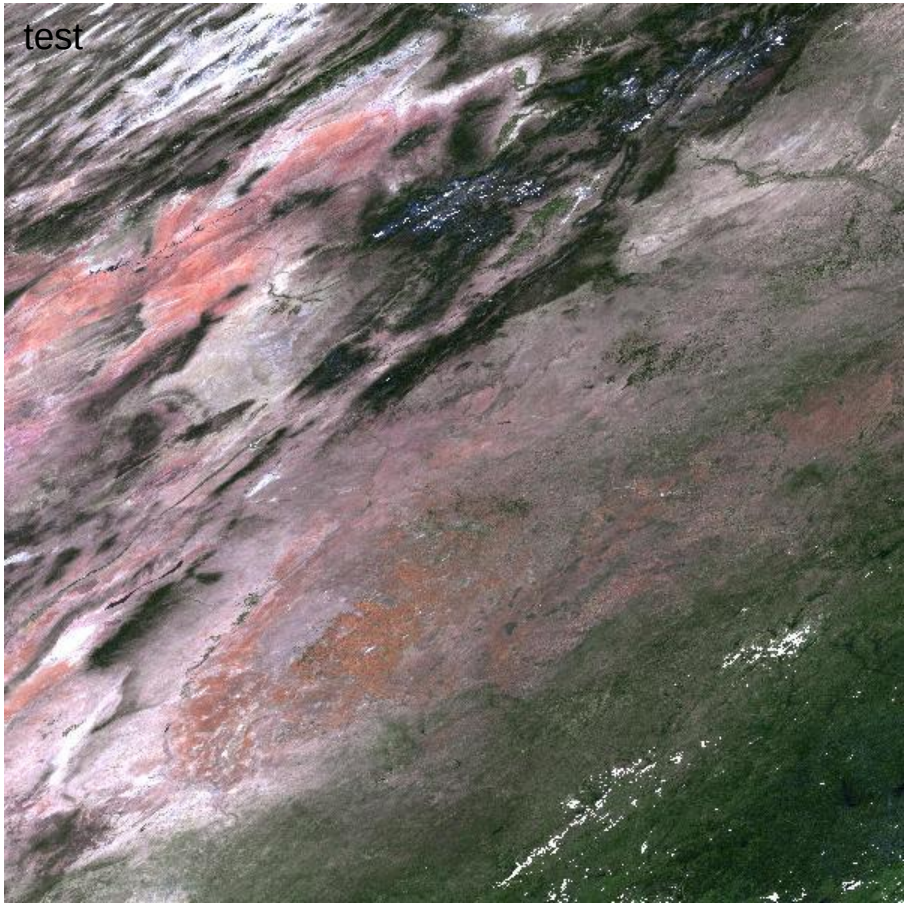
Absolute difference

- 0.0000 – 0.0010
- 0.0011 – 0.0020
- 0.0021 – 0.0030
- 0.0031 – 0.0040
- 0.0041 – 0.0050
- 0.0051 – 0.0060
- 0.0061 – 0.0070
- 0.0071 – 0.0080
- 0.0081 – 0.0090
- 0.0091 – 0.0100
- 0.0101 – 0.0200
- 0.0201 – 0.0300
- 0.0301 – 0.0400
- 0.0401 – 0.0500
- Fill value in test

Analysis of BRDF/Albedo: MCD43A4, 2003193, h09v05

- RGB composite from bands 1, 3 and 4

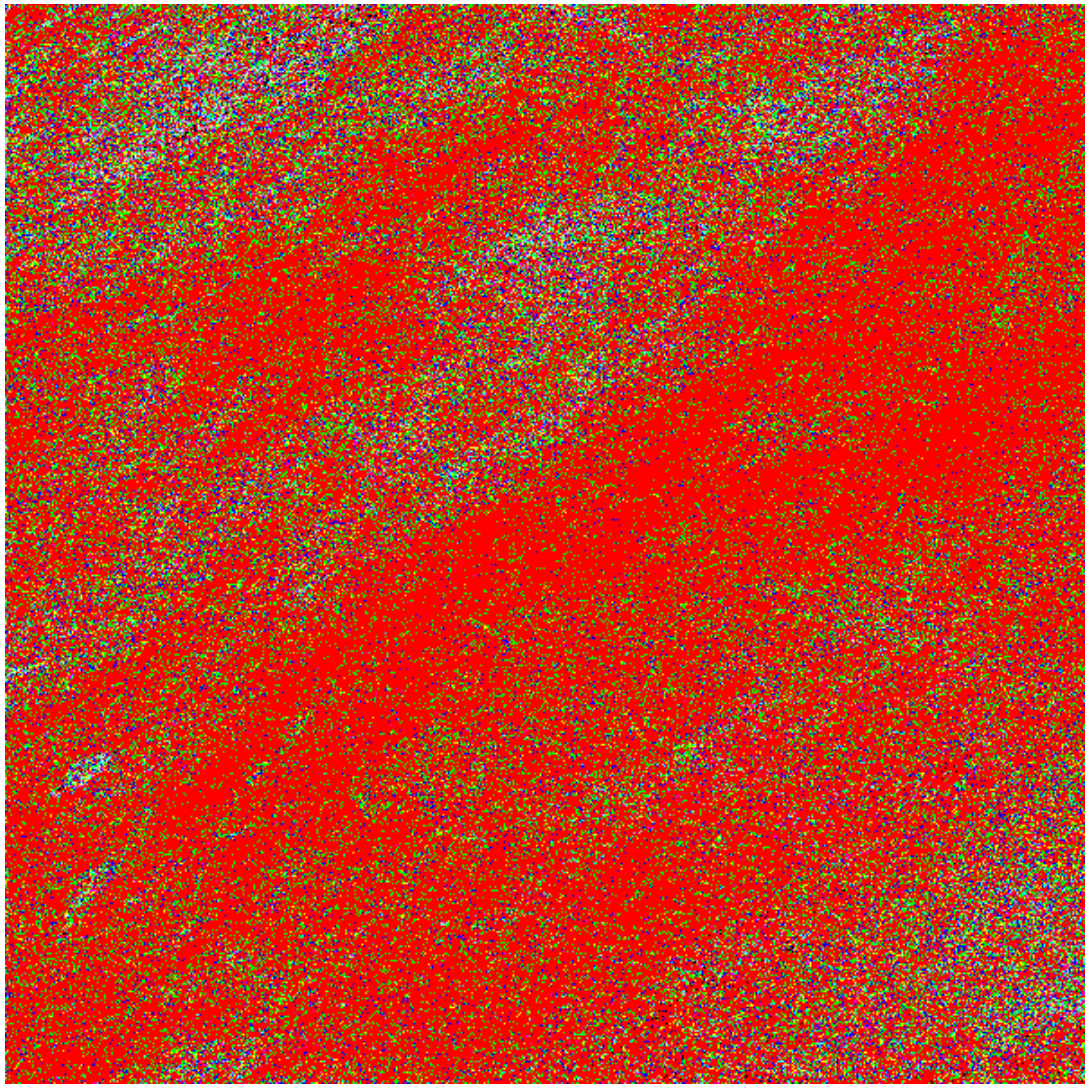




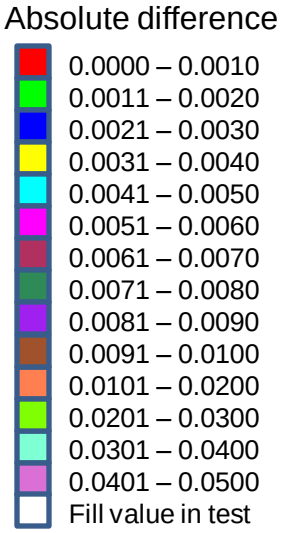
- Difference between the two version is hardly visible except at the edges of the cloud. Following slides shows the full tile difference image followed by many spatial subsets of the two data versions, difference image and the 2D scatter plot band1 reflectance.

Analysis of BRDF/Albedo: MCD43A4, 2003193, h09v05

- Absolute difference in NBAR – band1 (baseline – test)

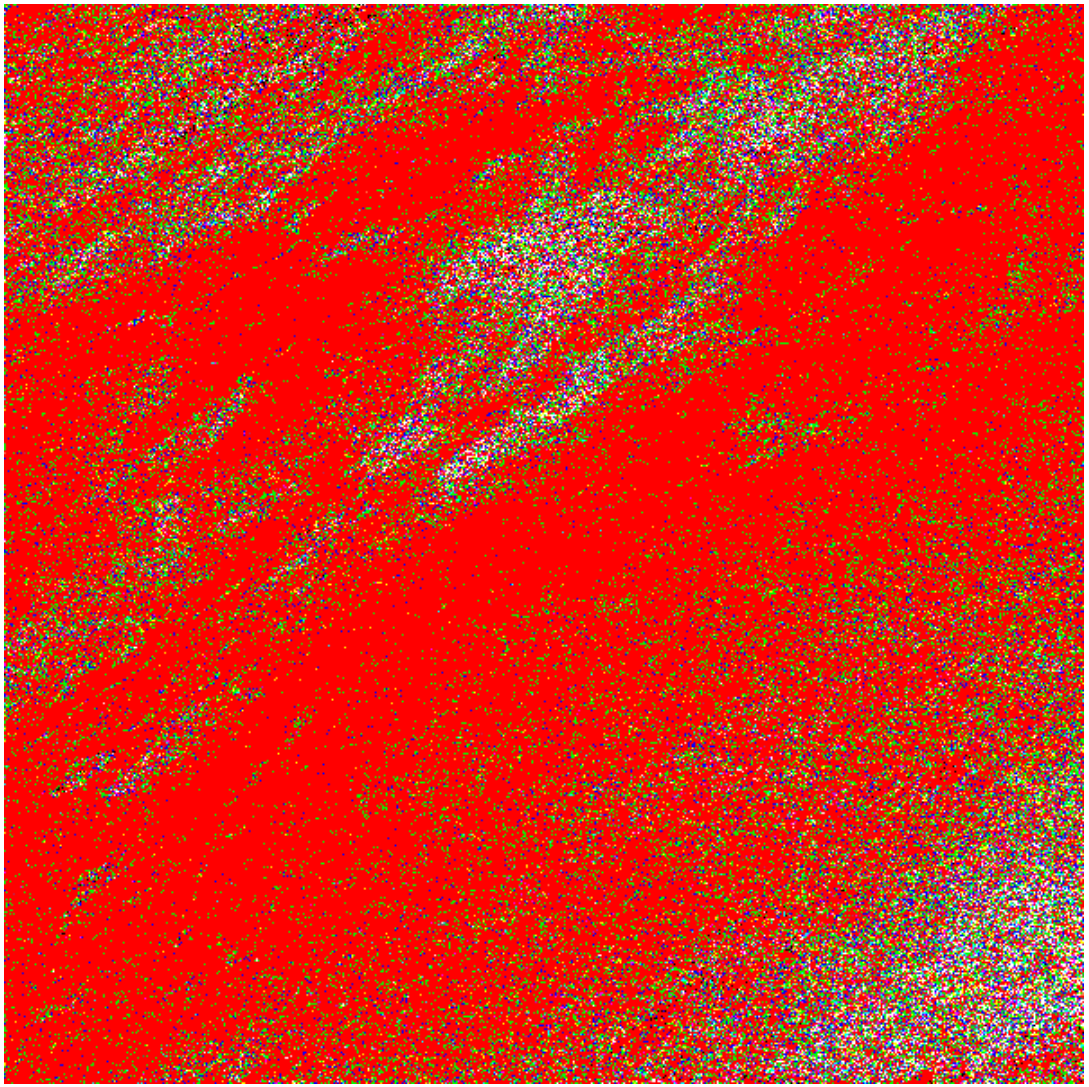


Most of the retrievals in the test version are within 0.006 of the retrieved value in the baseline version. There are few pixels for which surface reflectance could not be retrieved in the test version mostly around the cloudy area.

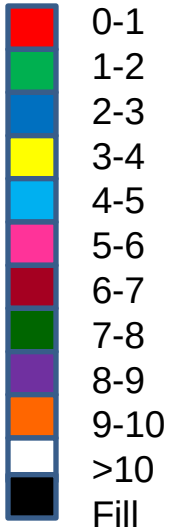


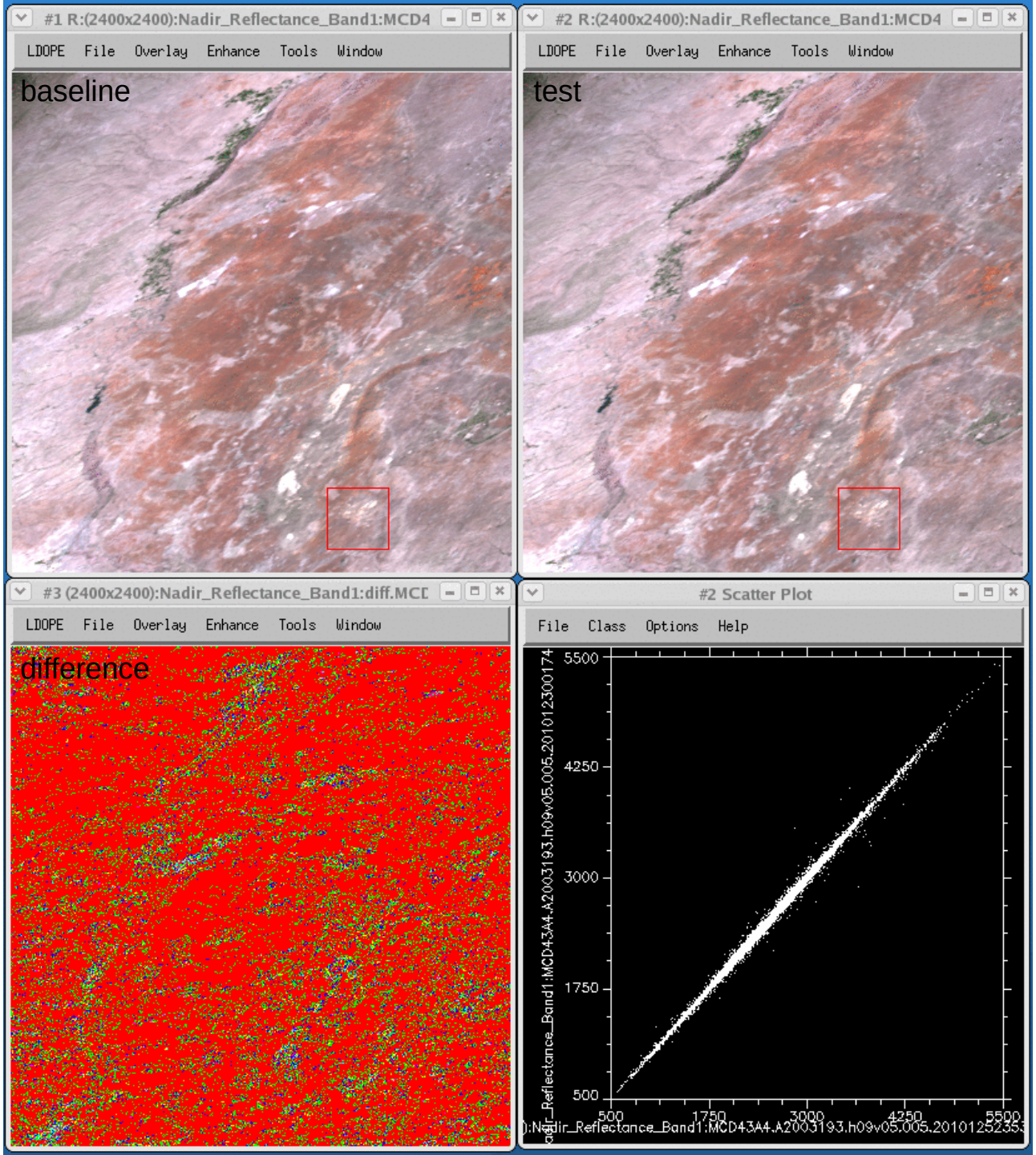
Analysis of BRDF/Albedo: MCD43A4, 2003193, h09v05

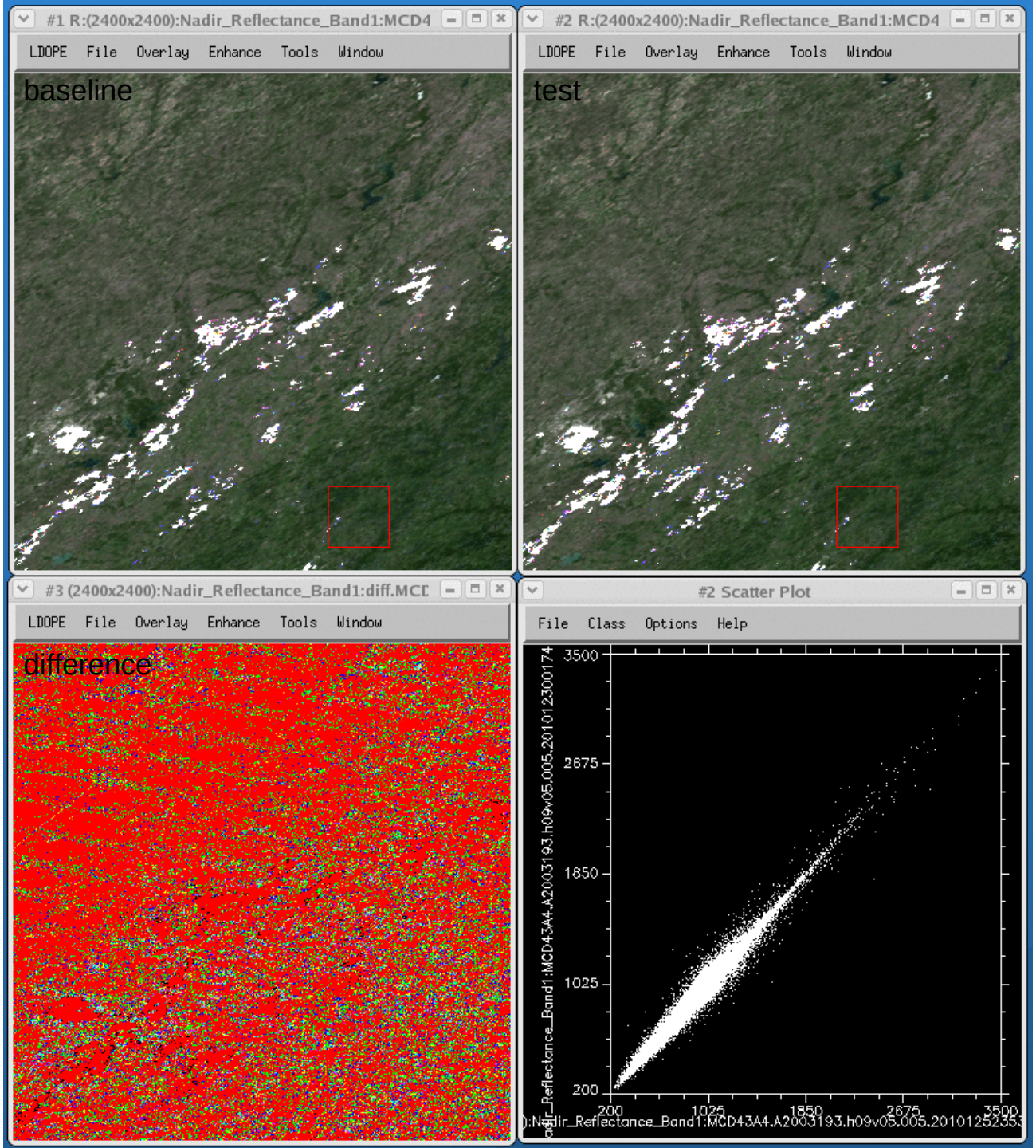
- Percentage relative difference in band1 (baseline – test)/baseline

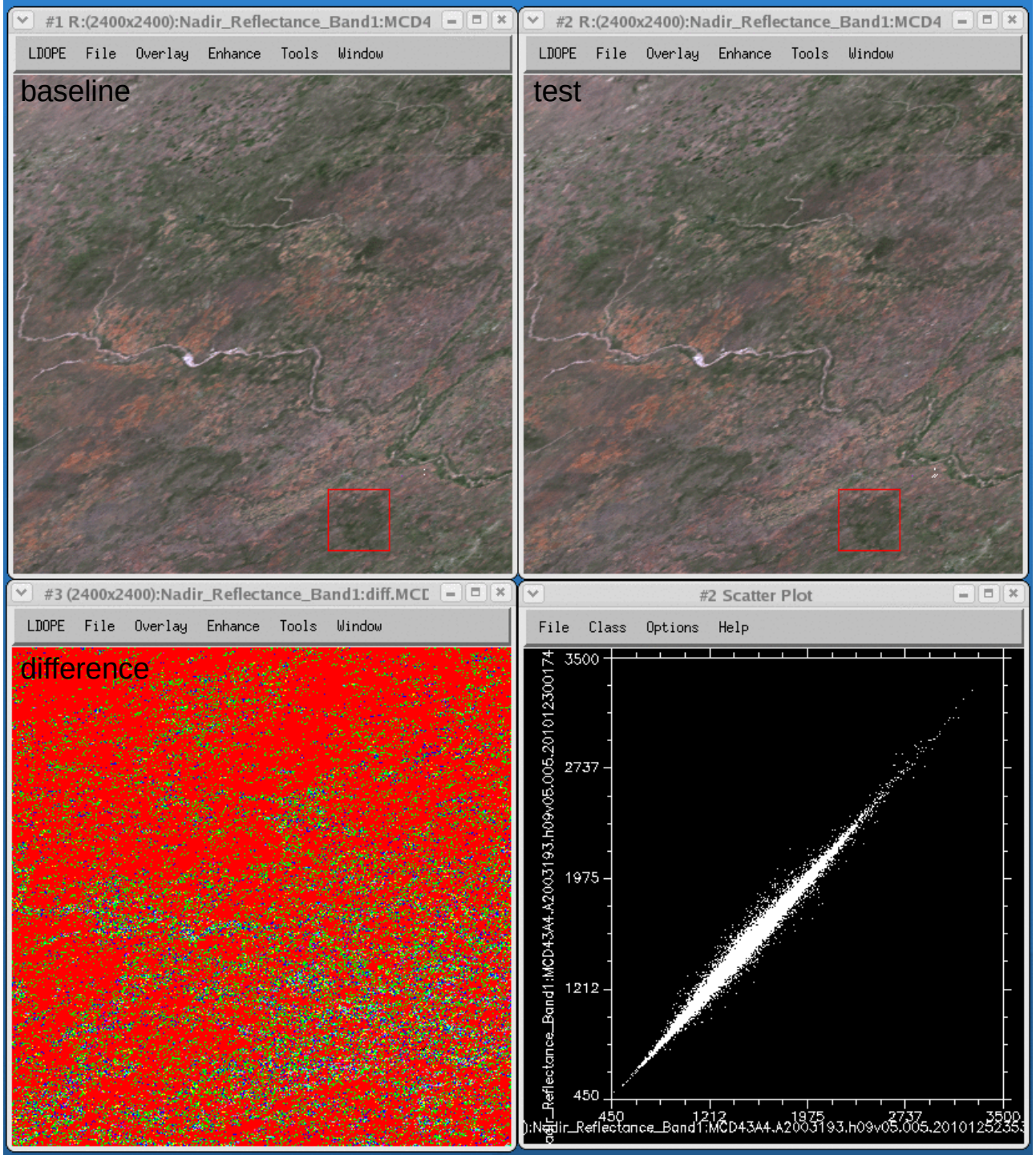


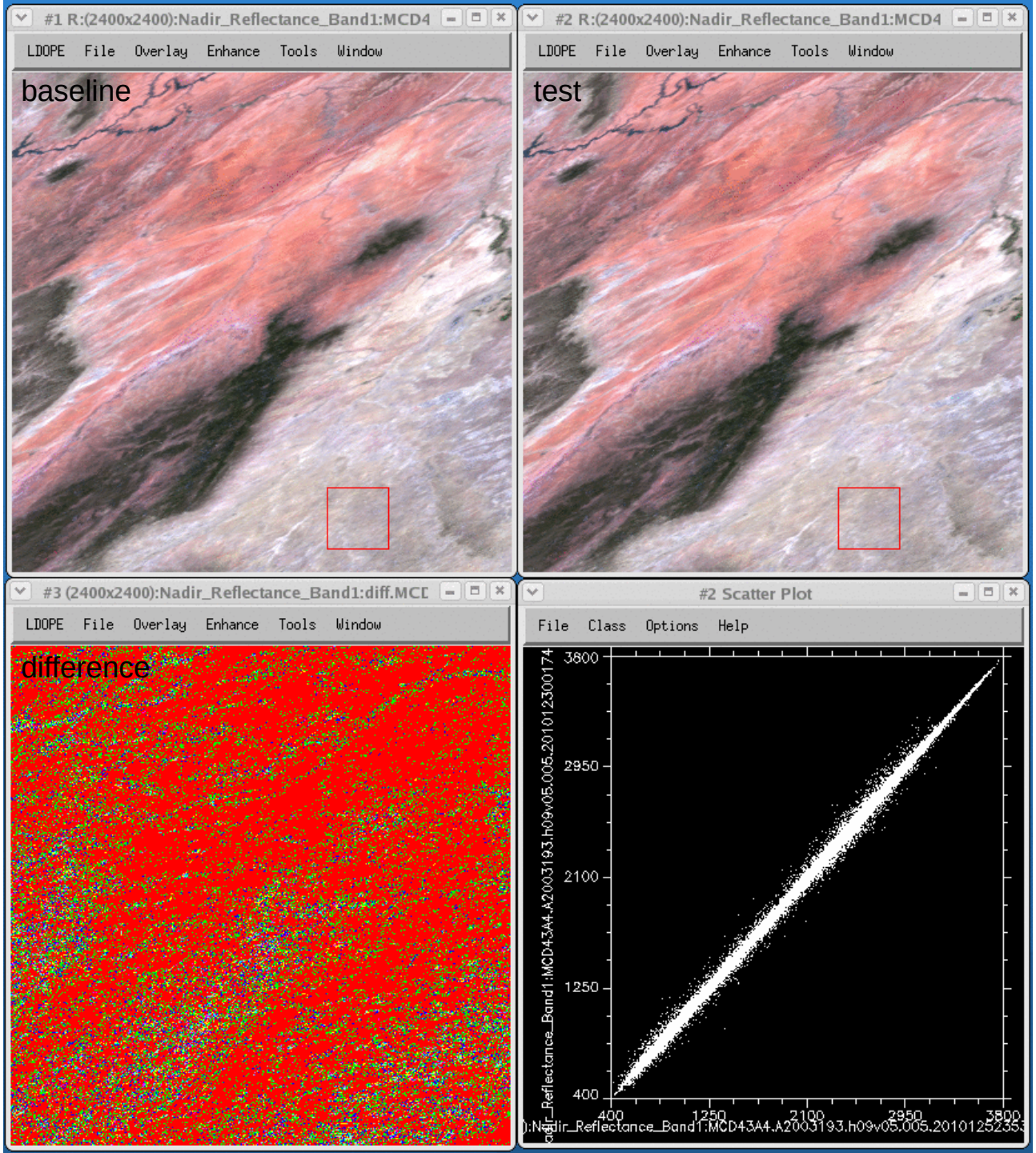
Large differences are concentrated near the cloud edges and at places where the reflectance is low

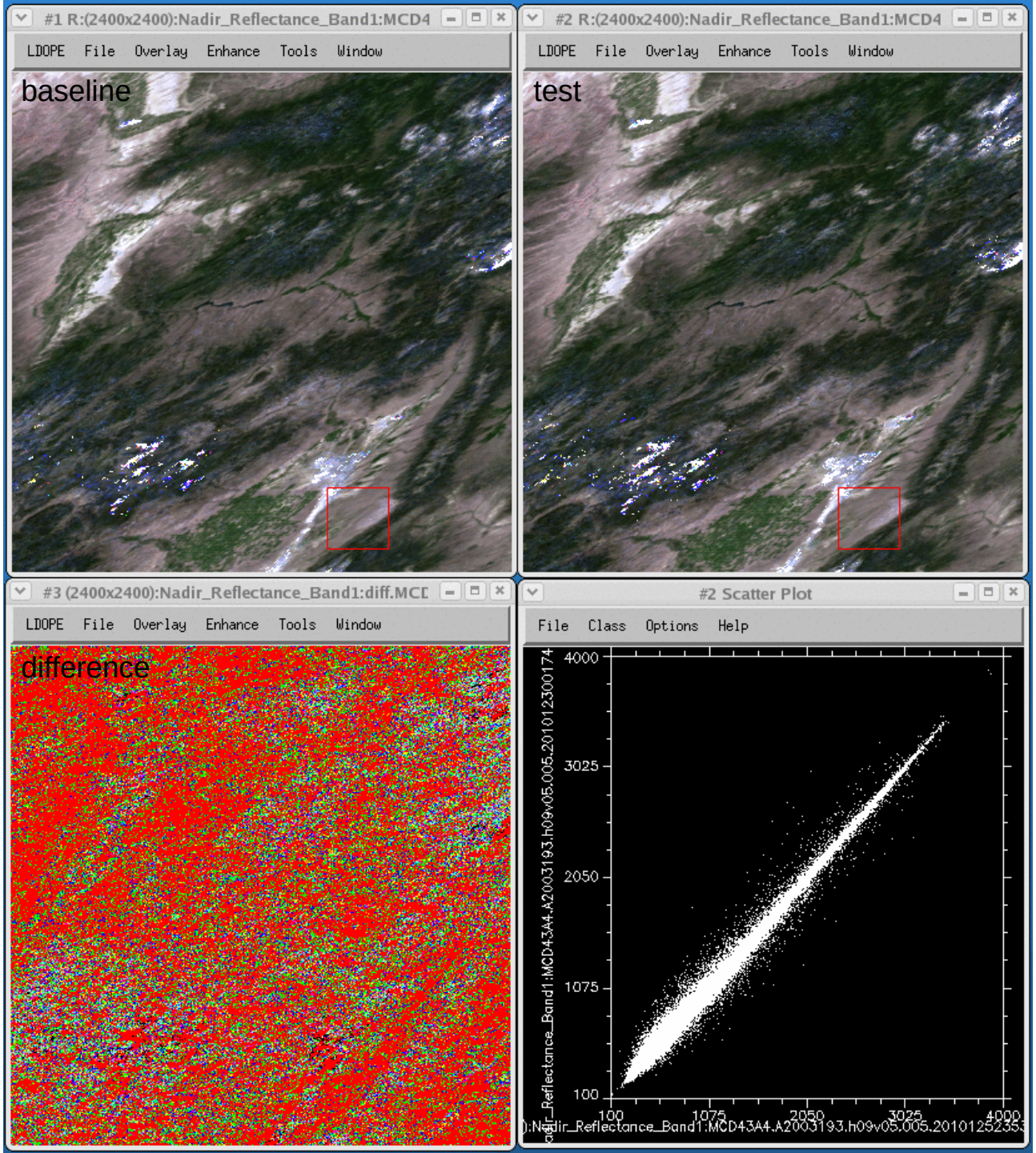


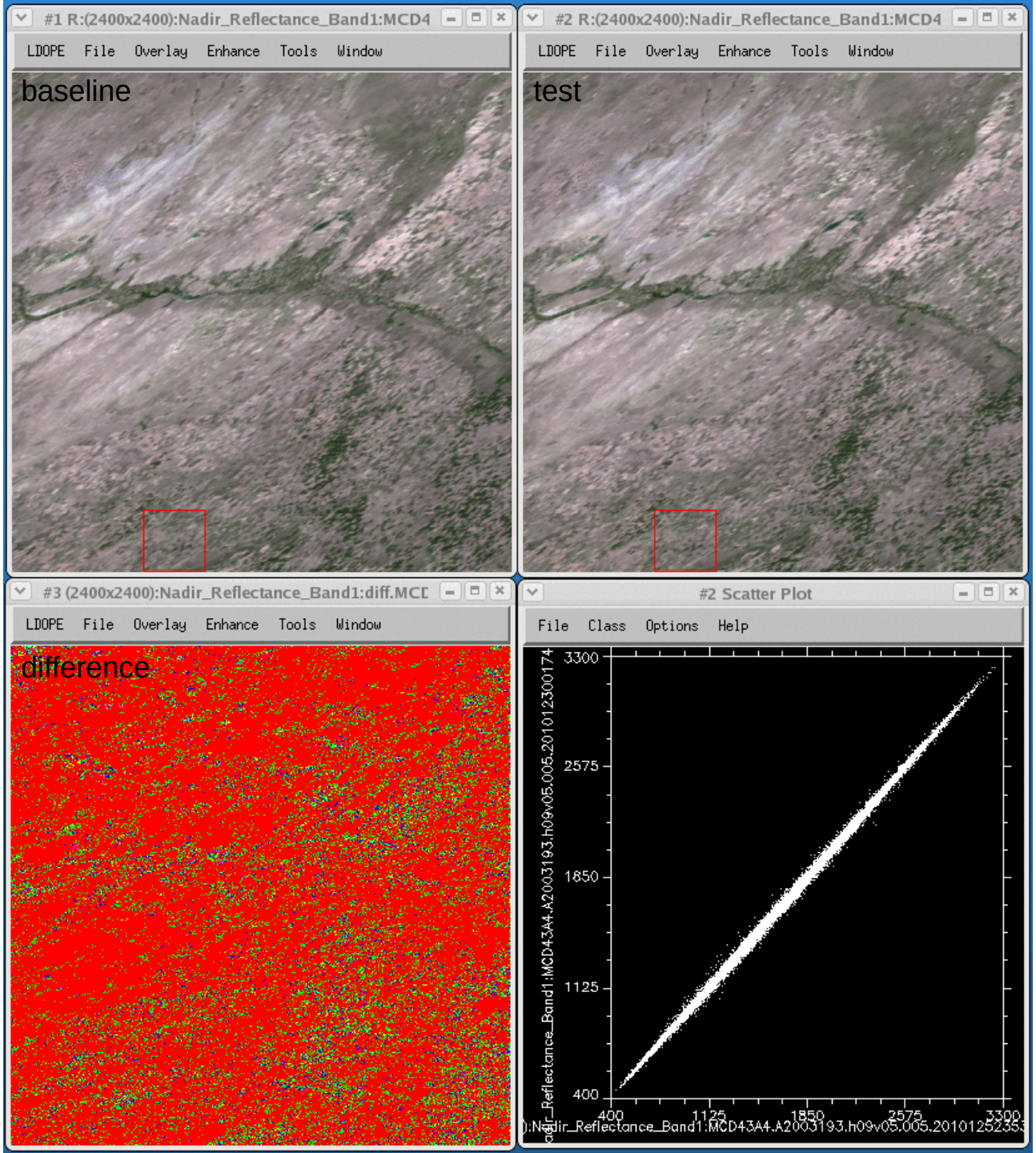

#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#3 (2400x2400):Nadir_Reflectance_Band1:diff.MCD
LDOPE File Overlay Enhance Tools Window
difference
#2 Scatter Plot
File Class Options Help
5500
4250
3000
1750
500
500
1750
3000
4250
5500
Absolute difference
0.0000 – 0.0010
0.0011 – 0.0020
0.0021 – 0.0030
0.0031 – 0.0040
0.0041 – 0.0050
0.0051 – 0.0060
0.0061 – 0.0070
0.0071 – 0.0080
0.0081 – 0.0090
0.0091 – 0.0100
0.0101 – 0.0200
0.0201 – 0.0300
0.0301 – 0.0400
0.0401 – 0.0500
Fill value in test


#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#3 (2400x2400):Nadir_Reflectance_Band1:diff.MCD
LDOPE File Overlay Enhance Tools Window
difference
#2 Scatter Plot
File Class Options Help
3500
2675
1850
1025
200
200
1025
1850
2675
3500
Absolute difference
0.0000 – 0.0010
0.0011 – 0.0020
0.0021 – 0.0030
0.0031 – 0.0040
0.0041 – 0.0050
0.0051 – 0.0060
0.0061 – 0.0070
0.0071 – 0.0080
0.0081 – 0.0090
0.0091 – 0.0100
0.0101 – 0.0200
0.0201 – 0.0300
0.0301 – 0.0400
0.0401 – 0.0500
Fill value in test


#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#3 (2400x2400):Nadir_Reflectance_Band1:diff.MCD
LDOPE File Overlay Enhance Tools Window
difference
#2 Scatter Plot
File Class Options Help
3500
2737
1975
1212
450
450
1212
1975
2737
3500
Absolute difference
0.0000 – 0.0010
0.0011 – 0.0020
0.0021 – 0.0030
0.0031 – 0.0040
0.0041 – 0.0050
0.0051 – 0.0060
0.0061 – 0.0070
0.0071 – 0.0080
0.0081 – 0.0090
0.0091 – 0.0100
0.0101 – 0.0200
0.0201 – 0.0300
0.0301 – 0.0400
0.0401 – 0.0500
Fill value in test

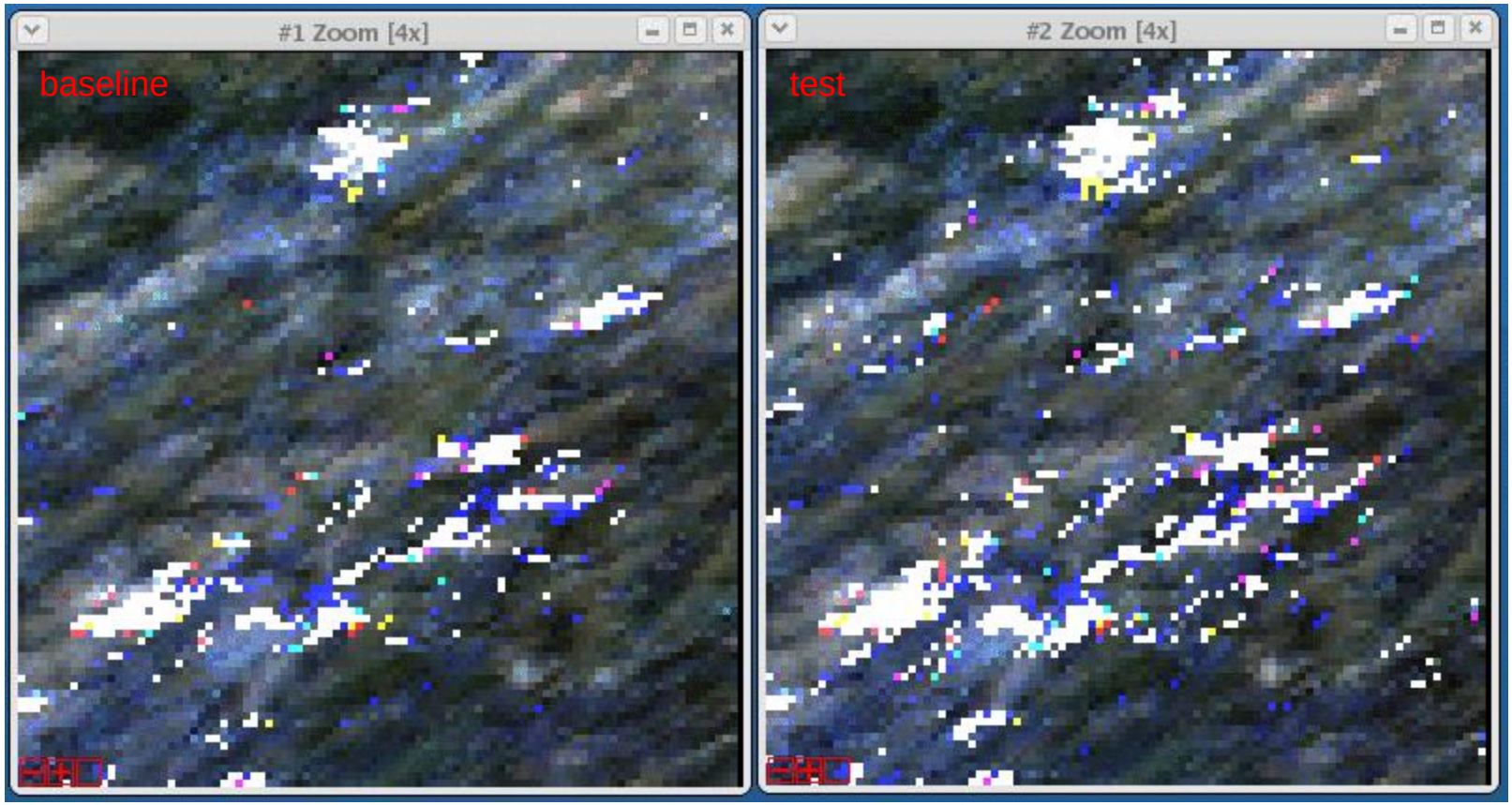

#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#3 (2400x2400):Nadir_Reflectance_Band1:diff.MCD
LDOPE File Overlay Enhance Tools Window
difference
#2 Scatter Plot
File Class Options Help
3800
2950
2100
1250
400
400
1250
2100
2950
3800
Absolute difference
0.0000 – 0.0010
0.0011 – 0.0020
0.0021 – 0.0030
0.0031 – 0.0040
0.0041 – 0.0050
0.0051 – 0.0060
0.0061 – 0.0070
0.0071 – 0.0080
0.0081 – 0.0090
0.0091 – 0.0100
0.0101 – 0.0200
0.0201 – 0.0300
0.0301 – 0.0400
0.0401 – 0.0500
Fill value in test


#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#3 (2400x2400):Nadir_Reflectance_Band1:diff.MCD
LDOPE File Overlay Enhance Tools Window
difference
#2 Scatter Plot
File Class Options Help
4000
3025
2050
1075
100
100
1075
2050
3025
4000
Absolute difference
0.0000 – 0.0010
0.0011 – 0.0020
0.0021 – 0.0030
0.0031 – 0.0040
0.0041 – 0.0050
0.0051 – 0.0060
0.0061 – 0.0070
0.0071 – 0.0080
0.0081 – 0.0090
0.0091 – 0.0100
0.0101 – 0.0200
0.0201 – 0.0300
0.0301 – 0.0400
0.0401 – 0.0500
Fill value in test


#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#3 (2400x2400):Nadir_Reflectance_Band1:diff.MCD
LDOPE File Overlay Enhance Tools Window
difference
#2 Scatter Plot
File Class Options Help
3300
2575
1850
1125
400
400
1125
1850
2575
3300
Absolute difference
0.0000 – 0.0010
0.0011 – 0.0020
0.0021 – 0.0030
0.0031 – 0.0040
0.0041 – 0.0050
0.0051 – 0.0060
0.0061 – 0.0070
0.0071 – 0.0080
0.0081 – 0.0090
0.0091 – 0.0100
0.0101 – 0.0200
0.0201 – 0.0300
0.0301 – 0.0400
0.0401 – 0.0500
Fill value in test

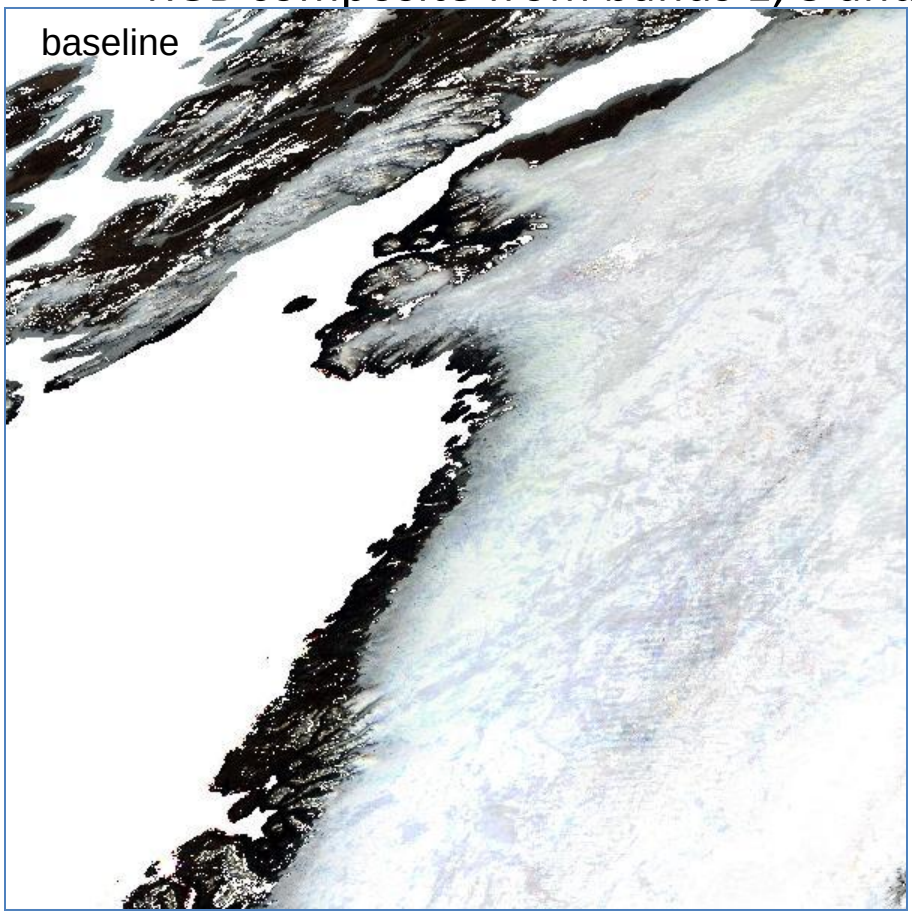
Day 2003193, tile h09v05

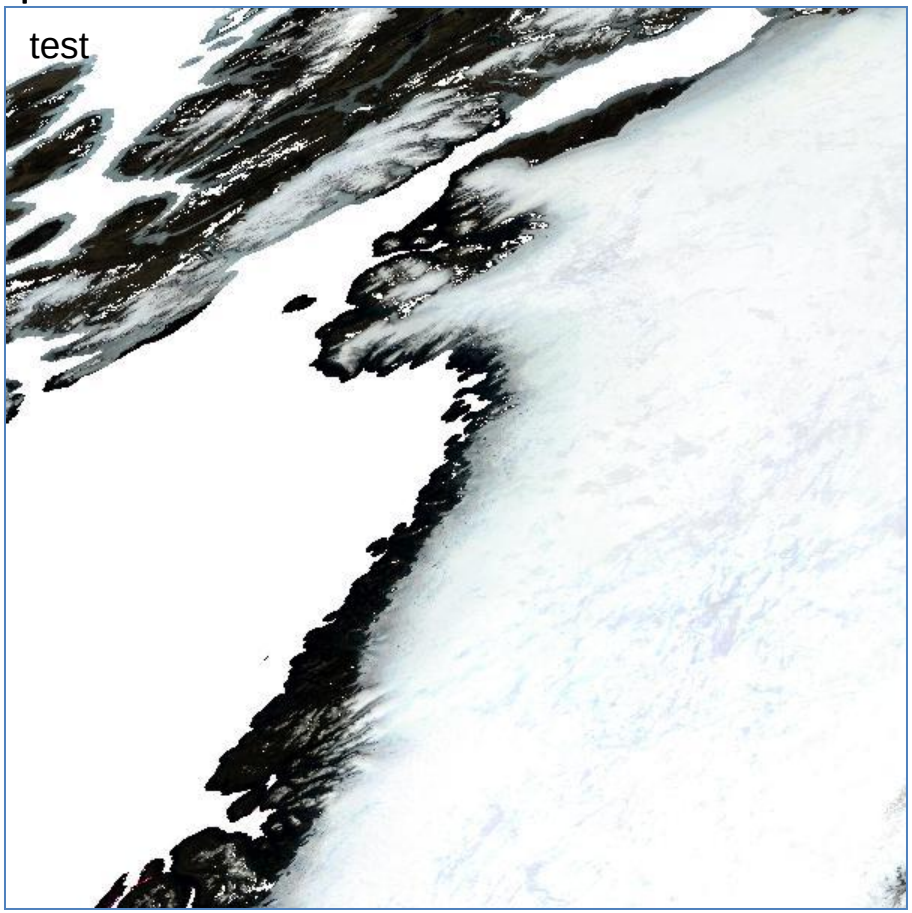
- Following example subset images show few pixels at the edges of the cloud that could not be retrieved in the test version.



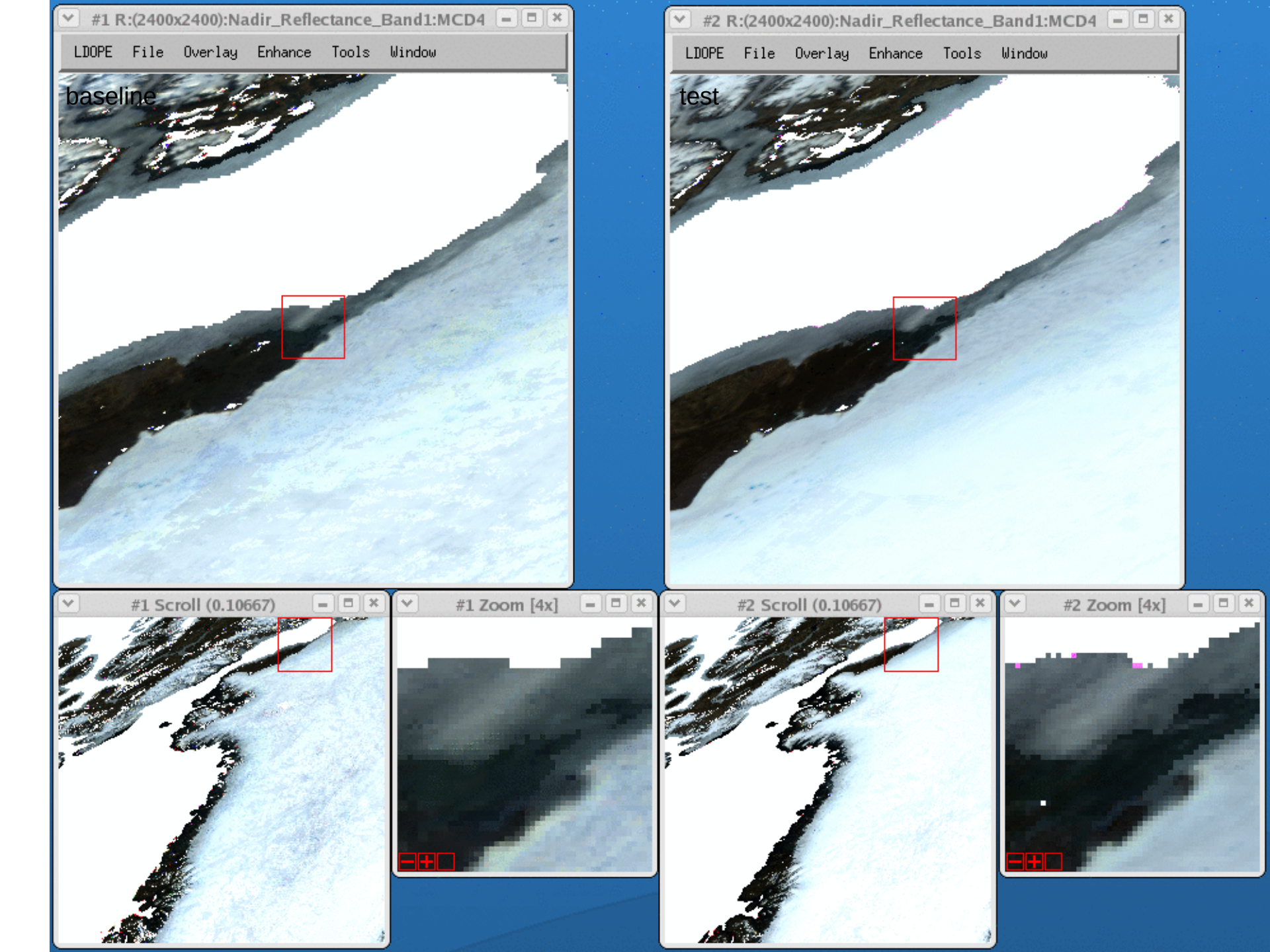
Analysis of BRDF/Albedo: MCD43A4, 2003193, h16v01

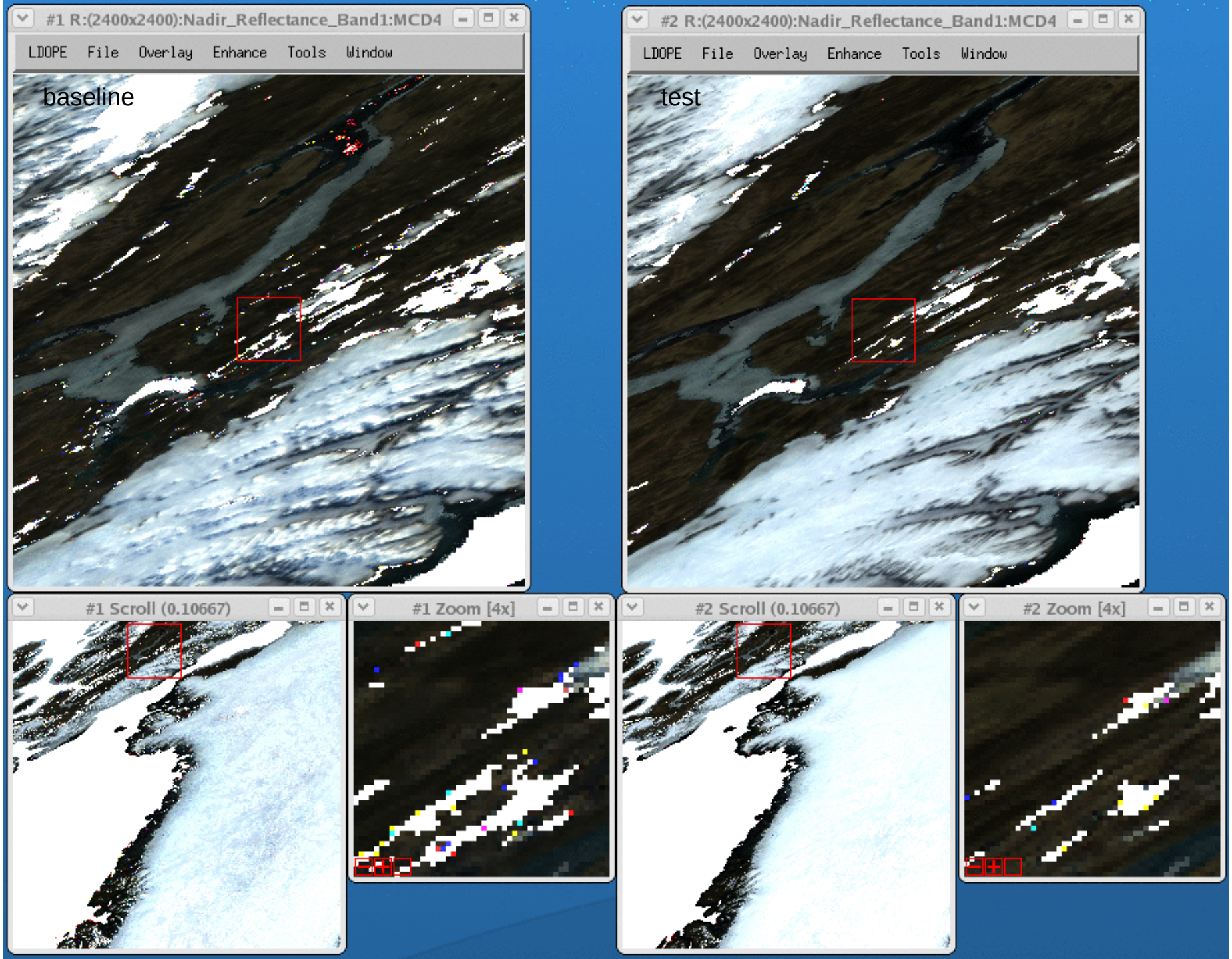
- RGB composite from bands 1, 3 and 4

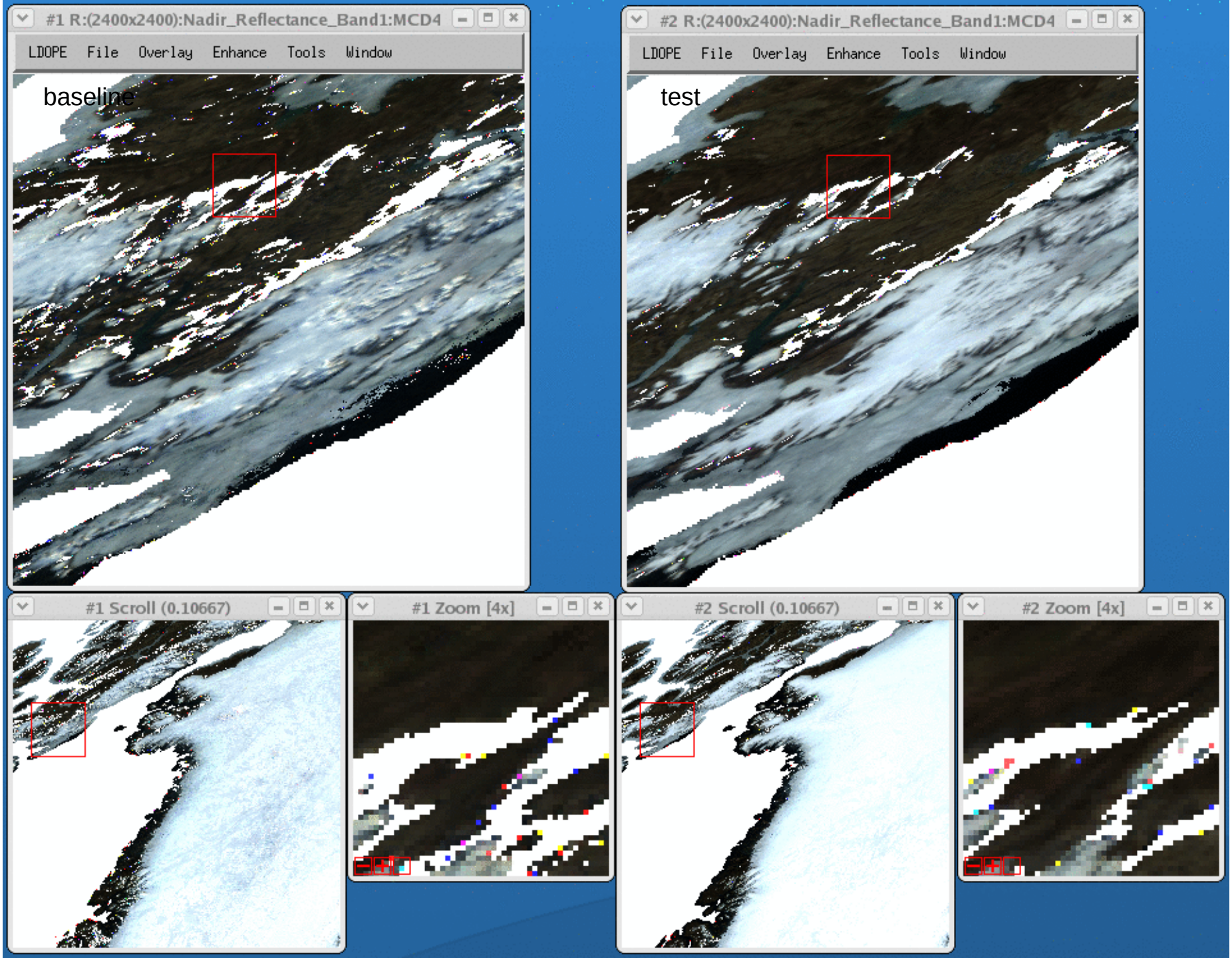


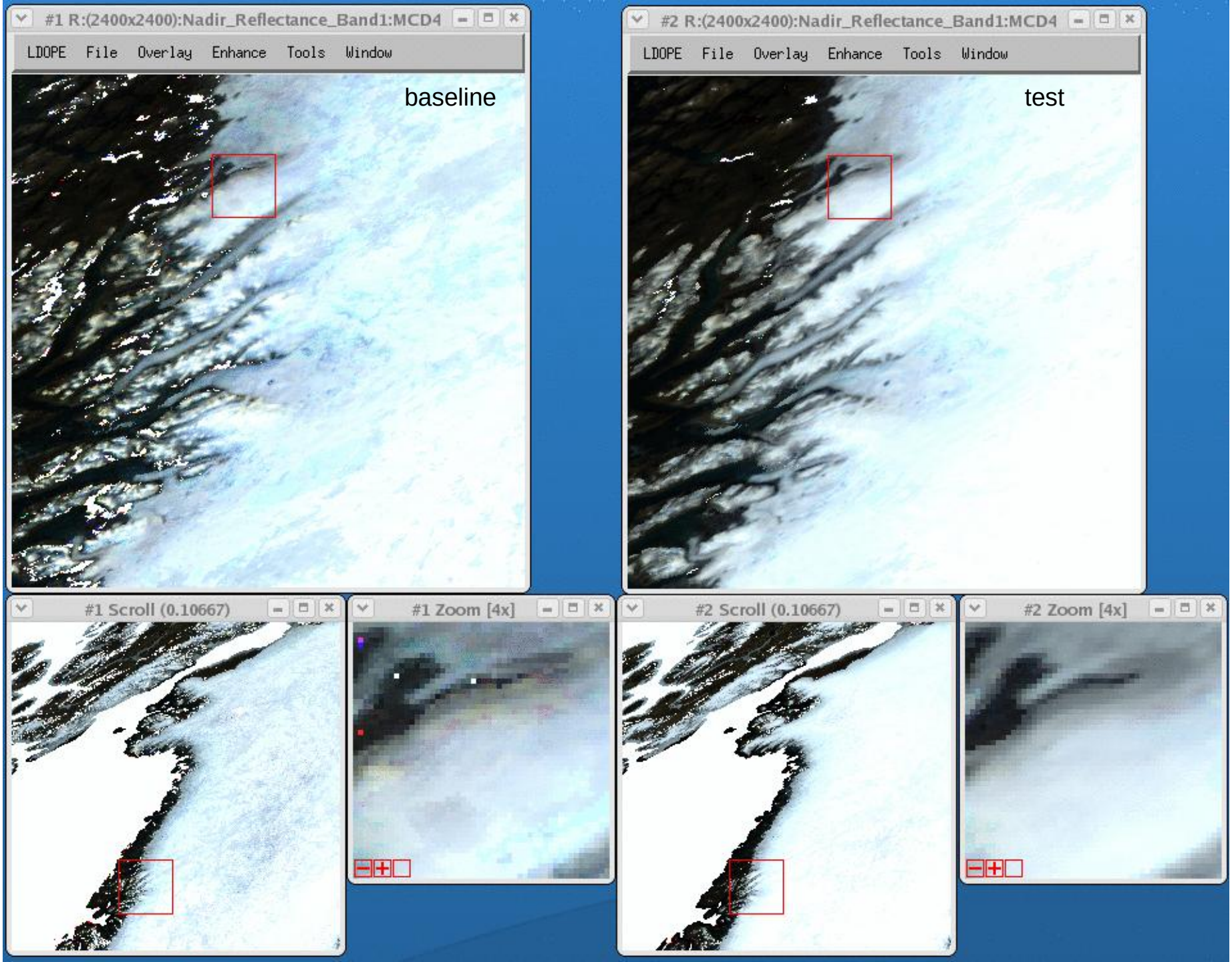


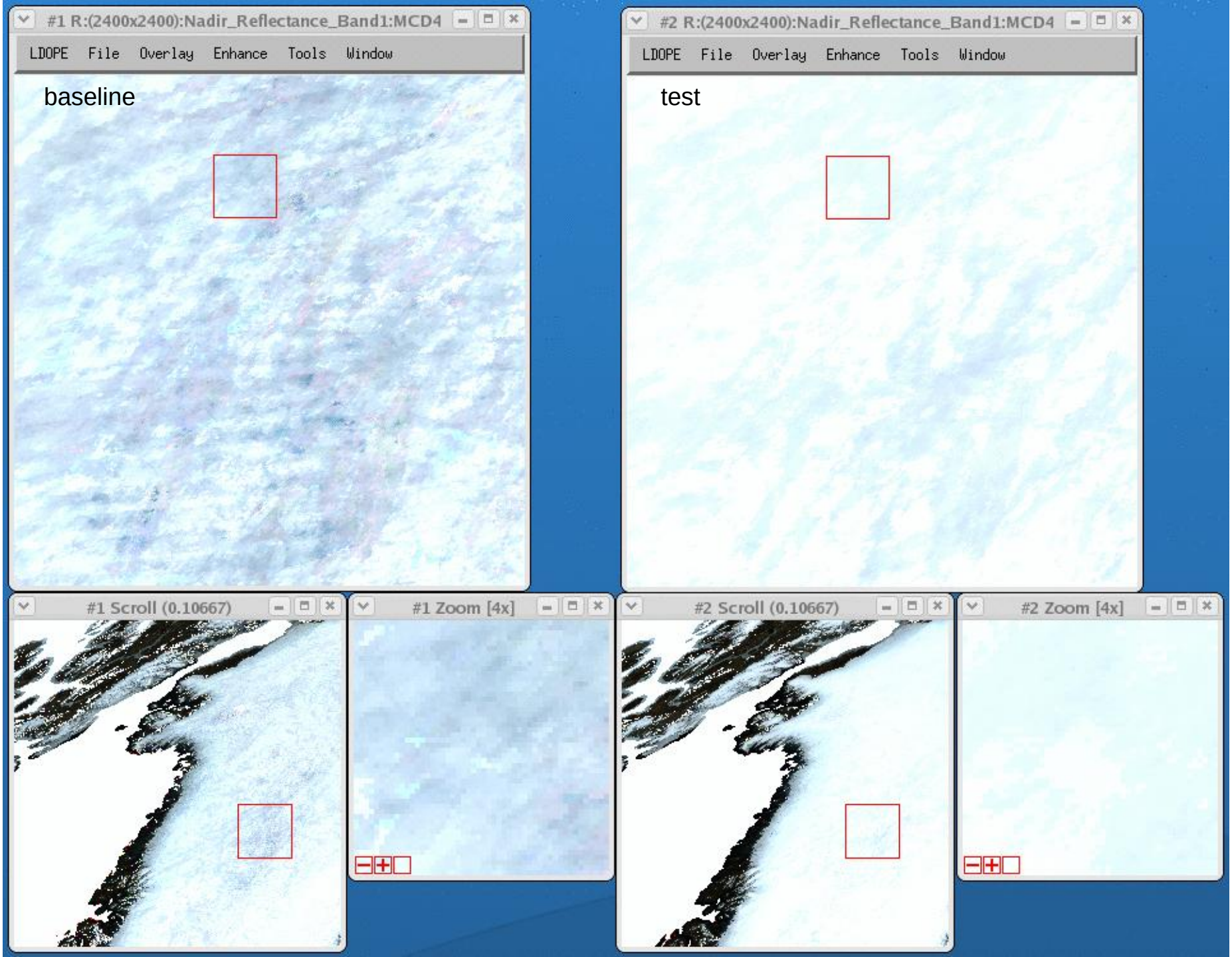
- The test version show significant improvement most likely resulting from use of all the available observation.
- The next slides show different spatial subsets – in all cases the new version looks better than the baseline version.


#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#1 Scroll (0.10667)
#1 Zoom [4x]
#2 Scroll (0.10667)
#2 Zoom [4x]


#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#1 Scroll (0.10667)
#1 Zoom [4x]
#2 Scroll (0.10667)
#2 Zoom [4x]


#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#1 Scroll (0.10667)
#1 Zoom [4x]
#2 Scroll (0.10667)
#2 Zoom [4x]


#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#1 Scroll (0.10667)
#1 Zoom [4x]
#2 Scroll (0.10667)
#2 Zoom [4x]

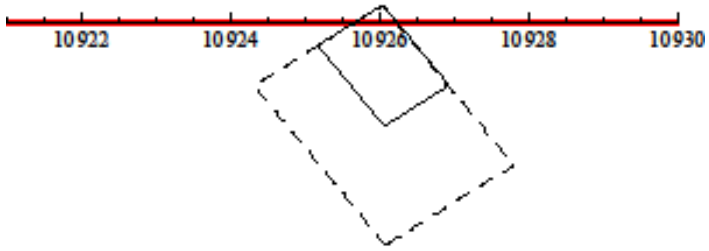

#1 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
baseline
#2 R:(2400x2400):Nadir_Reflectance_Band1:MCD4
LDOPE File Overlay Enhance Tools Window
test
#1 Scroll (0.10667)
#1 Zoom [4x]
#2 Scroll (0.10667)
#2 Zoom [4x]

Conclusion (1/3)

- Analysis of MOD09A1 confirms the fix to L2G-lite is working as expected.
- This fix to L2G-lite seems to have improved the quality of the BRDF/Albedo significantly.
- Change in BRDF algorithm to include all available observation has improved the quality of the product at high latitude.
- Some minor issues discovered in the L2G-lite have been already fixed (see the following slides).
  - These changes haven't been tested yet. The 16-day global test will be repeated with some limited evaluation of the test results. These fixes are not expected to make any significant difference to the downstream product quality.

Conclusion (2/3)

- Fill value for QC_500m (MOD09GA)
  - This just needed to be set to 787410671, instead of 0xFFFFFFFF
- Fill value in Band 20 (MODTBGA)
  - Fixed. The values in "fill_out_1km" were a slightly out of order.
- Missing observations along the intersection of the orbits (MOD09GQ)
  - It turns out that all 250m quadrants (pixels) of a 500m grid cell where being set to have the same number of observations as the 500m cell. This turns out not be the case around the edges of a scan. A 250m observation can cover a 500m grid cell in a few quadrants, but does not necessarily cover all 4 quadrants. The nobs is incorrectly set to 0. Also, incorrectly, the nobs for some 250 observations were set to 2, when they should be set to 1. This has been now fixed.

Conclusion (3/3)

- Less number of observations along the edge of the tile (in MOD09GA and MOD09GQ)
  - **By observation of Code (Cid Praderas):** Nothing wrong here. The 500m pixels are pointing to 1km pixels where the row and offsets are -8 and nobs = 1 (so nothing available in the compact layers). In the 500m Pointer files (MODPTHKM) the "offset_res_1" values are set to 136 and nobs = 1. The 250m pixels have less nobs corresponding to these 500m pixels.
  - **Theoretical explanation (Virginia Kalb):** An observation is included in a tile grid cell if some specified percentage of the observation overlaps that cell. Along the edges of the tile, it can happen that the 500 meter observation meets that criterion, while its parent 1km observation does not, as the figure shows. The red line is part of the bottom edge of the tile, the dashed rectangle is a 1km observation, and the solid rectangle is a 500 meter observation."